National Park Service—Arctic Network

Inventory and Monitoring Program

Freshwater Monitoring Scoping Workshop Notebook

June 2–4, 2004

Springhill Suites, Fairbanks, Alaska

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Freshwater Scoping Workshop
Arctic Network, National Park Service

Purpose of the Workshop

The Purpose of this workshop is to provide a forum for NPS resource managers and scientists to discuss ideas for building a statistically sound, ecologically-based, management-relevant, and affordable monitoring program for the Arctic Network (ARCN) of Parks. The information gleaned from this Freshwater Workshop will be used to form the basis for drafting a long-term monitoring plan for the Arctic Network (ARCN). All sections of this notebook are in draft form and will be revised after input from participants is received.

Objectives for the Scoping Workshop

1. Review and Discuss Conceptual Modeling Effort
2. Identify Specific Monitoring Questions for Freshwater Ecosystems
3. Identify Possible Sampling Methodologies for High Priority Monitoring Questions

Arctic Network, National Park Service
Freshwater Monitoring – Scoping Workshop

Agenda

June 2, 3, and 4, 2004
Fairbanks, Alaska – Springhill Suites Hotel

Objectives for the Scoping Workshop

1. Review conceptual ecosystem models and general monitoring framework
2. Develop Working Groups' highest priority candidate questions for freshwater monitoring
3. Identify suggestions for sampling methodologies for highest priority monitoring questions

Wednesday, 2 June

4:00	Arrival and Refreshments
4:30	Discussion of preliminary notebook materials: participants are asked to make informal comments on the notebook. See worksheet A (page 9).
5:30	Adjourn for dinner
6:00	Gather for dinner at Gambardella's Pasta Bella, 706 Second Avenue

Agenda

Thursday, 3 June

Objectives for Day Two

1. Discuss/ review conceptual ecosystem model
2. Working Groups develop comprehensive list of monitoring questions

8:00	Arrival and Continental Breakfast
8:30	Introductions Welcome: Dave Mills Review of Agenda: April Crosby, Meeting Facilitator Inventory and Monitoring Program: Sara Wesser Overview of the Arctic Network: Diane Sanzone
9:30	Overview of the Arctic Parks: Jim Lawler
10:00	**----- BREAK -----**
10:20	Overview of Aquatics in the Parks: Amy Larsen and Diane Sanzone
10:50	Aquatic Sampling for Western Airborne Contaminants Assessment Project: Dixon Landers
11:10	Framework for Conceptual Model Development: Steve Young
11:40	Discussion and Suggestions for Conceptual Models
12:30	**----- LUNCH ------**
1:30	Instructions to Working Groups
1:45	Working Groups: Each Working Group will develop a comprehensive list of potential monitoring questions, organized by sections on Worksheet B (see page 11). The groups need not prioritize your questions at this point. A recorder for each group must type the questions into the electronic worksheet provided on the laptop, and be prepared to review questions with the whole group.
3:30	**----- BREAK -----**
3:50	Reports from Working Groups
4:45	Review Question Set for Omissions, Duplication, etc.
5:00	Adjourn for dinner
6:00	Out of town participants gather at Pike's Landing for dinner, 4438 Airport Way

Agenda

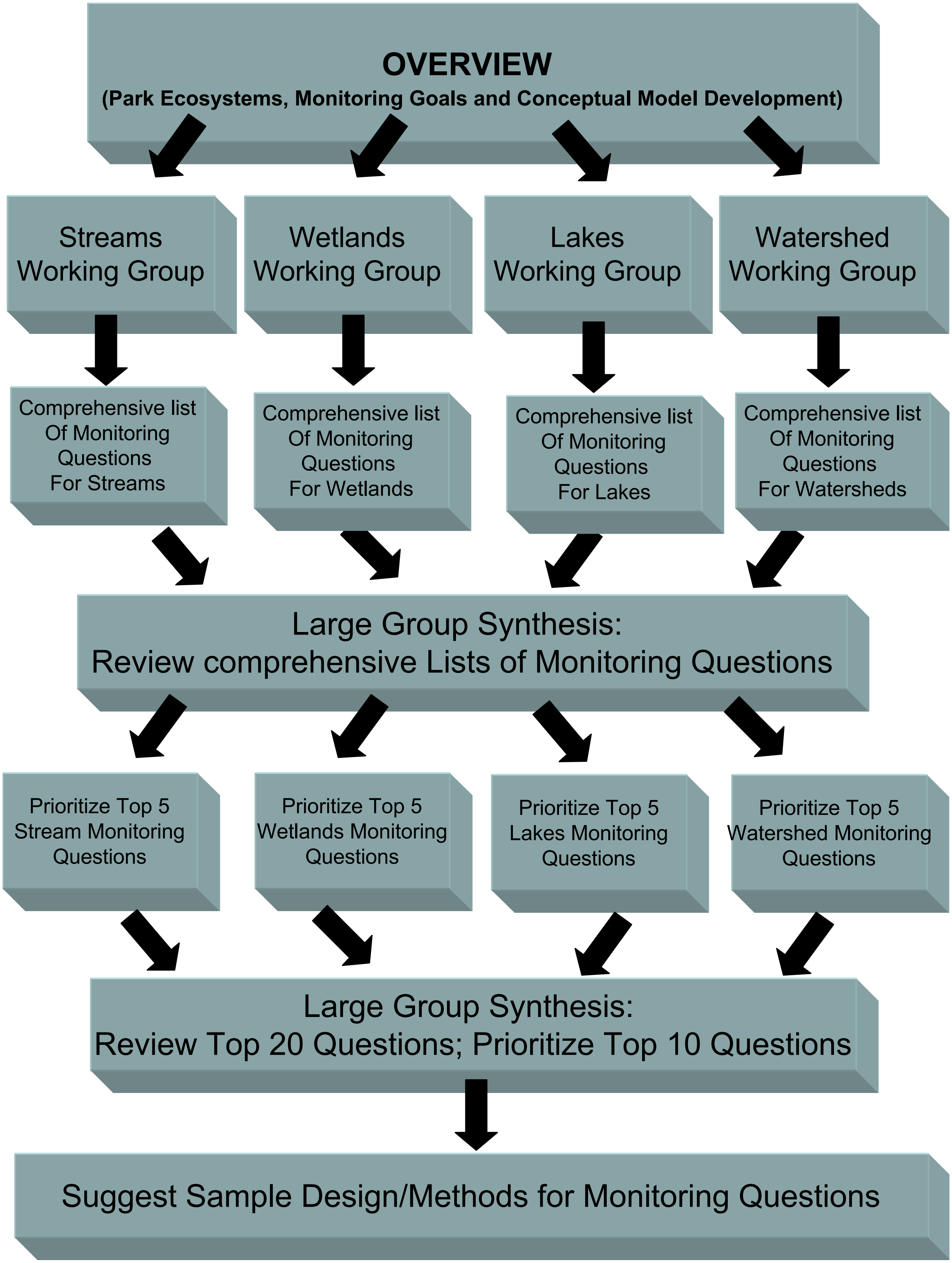
Friday, 4 June

Objectives for Day Three

1. From yesterday's list, identify top 10 priority questions for monitoring
2. Develop initial suggestions for monitoring design for highest priority questions

8:00	Arrival and Continental Breakfast
8:30	Review and Revise Agenda
8:35	Working Groups: Develop from the list of monitoring questions the ten highest priority candidates for monitoring. See Worksheet C, page 13. Identify these candidates on the electronic worksheets provided, and write each of the top-priority candidates on a page of flip chart paper (for eventual use by the whole group).
10:15	**----- BREAK -----**
10:35	Reports from Working Groups on monitoring priorities
11:30	Large group discussion: Are we missing any of the key ecosystem components or anthropogenic stressors?
12:00	**----- LUNCH -----**
1:00	Watershed approach to monitoring: Diane Sanzone
1:15	Large group discussion: For the second part of this discussion, the whole group will identify the overall top ten highest priority monitoring questions from the previous work group discussions. Comments on the remaining questions will be noted.
2:30	**----- BREAK -----**
2:50	Large group discussion continues: Suggestions for study design for the 10 priority questions identified by the large group.
4:15	Reflection on the Workshop and Participants' Suggestions for the Network Monitoring Program
4:30	Adjourn

Flowchart of Workshop Strategy



Name: ____________________________________

Worksheet A (Please Complete Before the Workshop)

Please be prepared to discuss the first two questions on the first evening of the workshop.

1. Please state any initial thoughts and/or comments about the general monitoring strategy we have laid out in this notebook (see page 24).

2. Please comment on our initial framework for developing conceptual ecosystem models (see page 26).

Complete and think about for days 2 and 3:

3. Freshwater Ecosystems of the Arctic

   a. Please provide examples of key ecosystem components, processes and/or functions important to arctic aquatic ecosystems from your field of expertise.

   b. Please list the major anthropogenic stressors for each of the above ecosystem components/functions.

   c. Please think about what key ecosystem components or processes you might monitor to study the effect of the above stressors and how.

Name: ______________________________

Worksheet B (Day 2)
Working Group Session I

Thursday, June 3, 1:45 to 3:30 p.m.

Comprehensive List of Potential Monitoring Questions

Session Instructions: You have each been given copies of our initial stressor models. By now you should have a good understanding of some of the natural resources in the five parks and the enabling legislation that was important in creating them. We hope you have also had time to think about key drivers and/or stressors important to arctic ecosystems, and more specifically, to the parks.

You are divided into Working Groups by subject area expertise. The objective for this one hour and forty-five minute session is for each working group to develop a comprehensive list of the potential monitoring questions that your group considers important in your area. Your group's list of questions should identify those ecosystem attributes which, when studied, provide reliable signals regarding the condition of the ecosystem.

We have prepared a spreadsheet, on the laptop, that includes the following subsections to help your group develop its questions:

1. Working Group designation (streams, lakes, wetlands, or watershed dynamics)
2. Key ecosystem component or process
3. Main drivers and/or stressors effecting the above ecosystem component or process
4. Monitoring question or objective that addresses the ecosystem component, enabling us to have the best measure of how it is changing

Each Working Group should identify a recorder who will type the group's questions into the electronic worksheet provided on the laptop and who will review the questions while projected overhead for the whole group. Each group recorder will have about 15 minutes to discuss the questions.

Name: ______________________________

Worksheet C
Working Group Session II

Friday, June 4, 8:35 to 10:15 a.m.

Five Highest Priority Monitoring Questions

Session Instructions: Today's task is to determine which ecosystem components and/or processes will tell us the most about "the state of our parks" and how they are changing. Your Working Group should begin with the comprehensive list of questions developed yesterday, keeping in mind comments from other workshop participants during the whole group discussion of the questions yesterday afternoon. Keep in mind comprehensive monitoring goals relevant to your subject area, and what a monitoring program needs to track to understand the ecosystem condition.

Identify from your comprehensive list of questions the five highest priority monitoring questions and be prepared to discuss the rationale supporting their selection.

Your group recorder should type the five questions into the electronic worksheets provided. Someone in your group also needs to write each question on the top of a page of flip-chart paper, for use later by the whole group.

If your group has extra time, in preparation for the afternoon, begin to think about study design for obtaining the desired data for your priority monitoring objectives.

Participant List by Working Group

Working Group 1 (Wetlands)

Amy Larsen
YUGA- National Park Service

Karen Oakley
USGS, Alaska Science Center

Peter Neitlich
WEAR- National Park Service

Walter G. Sampson
Kobuk Valley National Park SRC

Brad Shults
WEAR- National Park Service

Working Group 2 (Streams)

David Payer
Arctic National Wildlife Refuge-USFWS

Nick Hughes
University of Alaska Fairbanks

Jim Finn
USGS, Alaska Science Center

Fred Anderson
YUGA- National Park Service

Pollock Simon
Gates of the Arctic SRC

Working Group 3 (Lakes)

Chris Luecke
Utah State University

John Hobbie
Marine Biological Laboratory

Dixon Landers
U. S. Environmental Protection Agency

Thomas Heinlein
WEAR- National Park Service

Thomas J. Liebscher
YUGA- National Park Service

Working Group 4 (Watershed dynamics)

Andrew Balser
University of Alaska Fairbanks

Steve Young
Center for Northern Studies at Sterling College

Breck Bowden
University of Vermont

Larry D. Hinzman
University of Alaska Fairbanks

Jim Lawler
YUGA- National Park Service

Participant List

Fred Andersen
National Park Service
201 First Ave.
Fairbanks, AK 99701
Phone: 907-455-0621
Fax: 907-455-0601
Fred_Andersen@NPS.gov

Andrew Balser
311 Irving I
Institute of Arctic Biology
University of Alaska Fairbanks
Fairbanks, AK 99775
Phone: 907.474.2466
fnawb@uaf.edu

Breck Bowden
304 Aiken Center
Rubenstein School of Environment & Natural Resources
University of Vermont
Burlington, VT 05405
Phone: 802-656-2513
Fax: 802-656-8683
breck.bowden@uvm.edu

Jim Finn
USGS, Alaska Science Center
1011 East Tudor Rd.
Anchorage, AK 99503
Phone: (907) 786-3450
Fax: (907) 786-3636
jim_finn@usgs.gov

Thomas Heinlein
Resource Management Division, WEAR
National Park Service
PO BOX 1029
Kotzebue, AK 99752
Phone: 907-442-8303
Thomas_Heinlein@nps.gov

Larry D. Hinzman
Water and Environmental Research Center
Institute of Northern Engineering
University of Alaska Fairbanks
P.O. Box 755860
Fairbanks, Alaska 99775-55860
Phone: (907) 474-7331
FAX: (907) 474-7979
ffldh@uaf.edu

John Hobbie
Marine Biological Laboratory
7 MBL Street
Woods Hole, MA 02543
Phone: 508-289-7470
Fax: 508-457-1548
jhobbie@mbl.edu

Nick Hughes
School of Fisheries
245 O'Neill Building
University of Alaska Fairbanks
Fairbanks, AK 99775-7220
Phone: 907-474-7177
Fax: 907-474-7204
ffnfh@uaf.edu

Dixon Landers
U. S. Environmental Protection Agency
National Health and Environmental Effects Lab
Western Ecology Division
200 SW 35th Street
Corvallis, OR 97333
Phone: 541-757-4427
FAX: 541-754-4716
landers@mail.cor.epa.gov

Amy Larsen
YUGA
National Park Service
201 First Ave.
Fairbanks, AK 99701
Phone: 907-455-0622
Fax: 907-455-0601
Amy_Larsen@NPS.gov

Jim Lawler
YUGA
National Park Service
201 First Ave.
Fairbanks, AK 99701
Phone: 907-455-0624
Fax: 907-455-0601
Jim_Lawler@NPS.gov

Thomas J. Liebscher
YUGA
National Park Service
201 First Ave.
Fairbanks, AK 99701
Phone 907-455-0620
Fax 907-455-0601
Thomas_Liebscher@nps.gov

Chris Luecke
Department of Aquatic, Watershed & Earth Resources
Utah State University
Logan, UT 84322-5210
435-797-2463
Fax 435-797-1871
luecke@cc.usu.edu

Dave Mills
YUGA
National Park Service
201 First Ave.
Fairbanks, AK 99701
Phone 907-457-5752
Fax 907-455-0601
Dave_Mills@nps.gov

Peter Neitlich
WEAR
National Park Service
41A Wandling Rd
Winthrop, WA 98862
Phone: 509-996-3203
FAX: 509-996-8031
Peter_Neitlich@nps.gov

Karen Oakley
USGS, Alaska Science Center
Biological Science Office
1011 E. Tudor Rd., MS 701
Anchorage, AK 99503
Office: 907-786-3579
Fax: 907-786-3636
Karen_Oakley@usgs.gov

David Payer
Arctic National Wildlife Refuge
101 12th Ave, Room 236, Box 20
Fairbanks, AK 99701
Phone: 907/455-1830
Fax: 907/456 0428
david_payer@fws.gov

Walter G. Sampson
Kobuk Valley National Park SRC
PO Box 49
Kotzebue, AK 99752

Diane M. Sanzone
National Park Service
201 First Ave.
Fairbanks, AK 99701
Phone: 907-455-0626
Fax: 907-455-0601
Diane_Sanzone@NPS.gov

Brad Shults
WEAR
National Park Service
201 First Ave.
Fairbanks, AK 99701
Phone: 907-455-0674
Fax: 907-455-0601
Brad_Shults@NPS.gov

Pollock Simon
Gates of the Arctic SRC
PO Box 28
Allakaket, AK 99720
Phone: 907-968-2207
Fax: 907-968-2288

Steve Young
Center for Northern Studies at Sterling College
479 Cross Rd.
Wolcott, VT 05680
Phone:802-888-4331
sbyoung@pshift.com

National Framework for the Inventory and Monitoring Program of the National Park Service

The funding for this workshop comes from the Inventory and Monitoring (I&M) Program of the National Park Service (NPS). Established in 1992, the purpose of the I&M Program is to "develop scientifically sound information on the current status and long term trends in the composition, structure, and function of park ecosystems, and to determine how well current management practices are sustaining those ecosystems." In order to accomplish this mission the I & M program set out to: (1) provide a consistent database of information about our natural resources, including species diversity, distribution and abundance (12 Basic Inventories); and (2) determine the current condition of our resources and how they are changing over time (vital signs monitoring).

The I&M Program is vital to fulfilling the NPS's mission of protecting and preserving the natural resources of the national park system unimpaired for the use and enjoyment of current and future generations. The National Park Service Organic Act of 1916, clearly states that NPS lands will be managed:

> "... to promote and regulate the use of the federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as to conform to the fundamental purposes of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

More recently, the National Parks Omnibus Management Act of 1998 established the framework for fully integrating natural resource monitoring and other science activities into the management processes of the national park system. The act charges the secretary of the interior to:

> "continually improve the ability of the National Park Service to provide state-of-the-art management, protection, and interpretation of and research on the resources of the National Park System," and to "assure the full and proper utilization of the results of scientific studies for park management decisions."

The lack of scientific information about resources under NPS stewardship has been widely acknowledged as inconsistent with NPS goals and standards. In 1992, the National Academy of Science recommended that, "if this agency is to meet the scientific and resource management challenges of the twenty-first century, a fundamental metamorphosis must occur."

Congress reinforced this message in the text of the FY 2000 Appropriations Bill:

> "The Committee applauds the Service for recognizing that the preservation of the diverse natural elements and the great scenic beauty of America's national parks and other units should be as high a priority in the Service as providing visitor services. A major part of protecting those resources is knowing what they are, where they are, how they interact with their environment and what condition they are in. This involves a serious commitment from the leadership of the National Park Service to insist that the superintendents carry out a systematic, consistent, professional inventory and monitoring program, along with other

scientific activities, that is regularly updated to ensure that the Service makes sound resource decisions based on sound scientific data."

The nationwide Natural Resource Challenge program was put in place to revitalize and expand the natural resource program of the National Park Service. This effort increased funding to the I&M Program to facilitate improved baseline and long-term trend data for NPS natural resources. To efficiently and fairly use the funding available for inventories and monitoring, the 270 National Park Service units with significant natural resources managed by the service were organized into 32 biome based networks (Figure 1). Four networks were established in Alaska, clustering park units that share similar ecosystems and mandates (Figure 2). These networks have been designed to share expertise and infrastructure for both biological inventories and development of long-term ecological monitoring programs. The Arctic Network (ARCN) is the northern and western most unit in Alaska.

In order for this program to be highly accessible and useful to park managers, each network was advised to establish a Board of Directors and technical advisory committee to help plan and implement the monitoring program (Figure 3). The ARCN Board of Directors consists of three superintendents representing the park units, the Alaska Regional Inventory and Monitoring (I&M) coordinator, the ARCN I&M coordinator, and the Alaska Regional Science Advisor. The nine-member technical committee consists of the chiefs of resource management from each park unit, two natural resource scientists from each park unit, the ARCN I&M coordinator (chair), the Alaska Region I&M coordinator, and a USGS-Alaska Science Center liaison. Consultation with scientific experts and peer review are also encouraged in the development of the program.

Figure 1. National map of inventory and monitoring networks, including the four Alaskan networks.

Figure 2. *Alaska Region I&M Networks.*

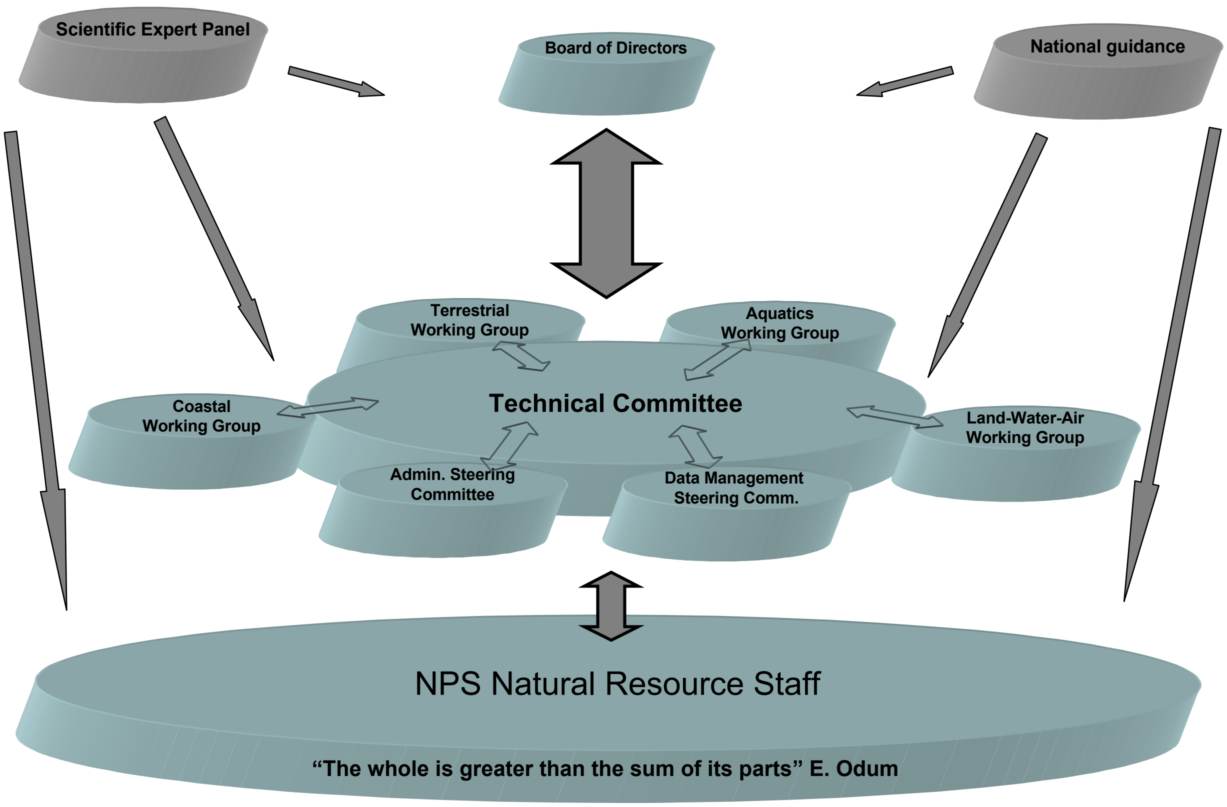


Figure 3. *ARCN Network Structure and Function*

The Arctic Network (ARCN)

The ARCN includes five NPS system units (Figure 4):

- Bering Land Bridge National Preserve (BELA),
- Cape Krusenstern National Monument (CAKR),
- Gates of the Arctic National Park and Preserve (GAAR),
- Kobuk Valley National Park (KOVA), and
- Noatak National Preserve (NOAT).

Collectively these units represent approximately 25% of the land area of NPS managed units in the United States. GAAR, KOVA, and NOAT are contiguous and encompass a large expanse of mostly mountainous arctic ecosystems at the northern limit of treeline. Immediately to the west of these units lie CAKR and BELA which border Kotzebue Sound. BELA and CAKR are similar with respect to their coastal resources and strong biogeographic affinities to the Beringian subcontinent—the former land bridge between North America and Asia. The ARCN park units are not connected to the road system. Much of the ARCN is designated or proposed wilderness.

Figure 4: *Arctic Network (ARCN) of the National Park Service's I&M Program*

All of the NPS units within the ARCN parks are relatively recent additions to the National Park System. Portions of BELA, CAKR, and GAAR were initially created by presidential proclamation in 1978. All 5 units were re-designated or created with their present boundaries by the Alaska National Interest Lands Conservation Act (ANILCA) in 1980. The recent origin of these remote and difficult-to-access units, coupled with limited natural resource staffing levels, has left the natural resources in these units relatively unstudied.

Freshwater Resources of ARCN

The ARCN parks have an extensive and diverse array of freshwater ecosystems which are relatively undisturbed by human activity. Key features of the landscape are the large freshwater lakes, seemingly endless miles of river networks, large expanses of wetlands, and unique isolated spring systems. There are seven wild and scenic rivers in the ARCN, including: the Noatak, Salmon, Kobuk, Alatna, John, Tinayguk, and North Fork of the Koyukuk. All of the rivers of the ARCN are free-flowing and run clear most of the year. There are a few glacial streams that originate in the Brooks Range and several spring streams, including tributaries of the Reed River, Kugrak River and Alatna River, although to date, little or no studies have been conducted on them.

Much of the land within the ARCN is drained by streams that flow from the uplands into lowland areas, then empty into the Chukchi Sea or coastal lagoons. These lagoons have been a primary fishing ground for native populations for the past 9000 years. During the ice-free season, some of these streams and associated coastal lagoons provide important habitat for anadromous and freshwater fish populations, birds and terrestrial mammals.

There are many lakes in the ARCN. Many of the large deep lakes such as Chandler, Selby, Feniak and Matcharak are renowned for their fisheries resources. These sites are heavily used by both subsistence and sport fishers. One of the largest, Walker Lake was designated a national natural landmarks in April 1968. Thousands of shallow lakes and wetlands are distributed throughout the parks. These ecosystems have diverse geologic origin including countless thaw ponds, kettle lakes, maars and oxbows that provide important rearing areas for fish, macroinvertebrates and waterfowl.

There is little or no information on ground water in these parks, although some larger geothermal systems have been studied (e.g. Serpentine Hot Springs).

Overall Goals of the ARCN Monitoring Program

The overall goal of natural resource monitoring in the National Parks is to develop scientifically sound information on the current status and long-term trends in the composition, structure, and function of park ecosystems, and to determine how well current management practices are sustaining those ecosystems.

NPS Vital Signs Monitoring Goals

1. Determine status and trends in selected indicators of the condition of park ecosystems to allow managers to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources.
2. Provide early warning of abnormal conditions of selected resources to help develop effective mitigation measures and reduce costs of management.
3. Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments.
4. Provide data to meet certain legal and congressional mandates related to natural resource protection and visitor enjoyment.
5. Provide a means of measuring progress towards performance goals.

In order to achieve the above goals the Arctic Network is following the basic approach to designing a monitoring program laid out in the National Framework. The process involves five key steps:

1. Define the purpose and scope of the monitoring program.
2. Compile and summarize existing data and understanding of park ecosystems.
3. Develop conceptual models of relevant ecosystem components.
4. Select indicators and specific monitoring objectives for each.
5. Determine the appropriate sampling design and sampling protocols.

These five steps are incorporated into a three-phase planning process that has been established for the NPS monitoring program (Figure 5). Phase 1 involves defining goals and objectives; beginning the process of identifying, evaluating, and synthesizing existing data; developing draft conceptual models; and determining preliminary monitoring questions. Phase 2 involves refining the conceptual ecosystem models and selecting "vital signs" that will be used as indicators to detect change. Phase 3 of the planning process involves: determining the overall sample design for monitoring; developing protocols for monitoring; and production of a data management plan for the network.

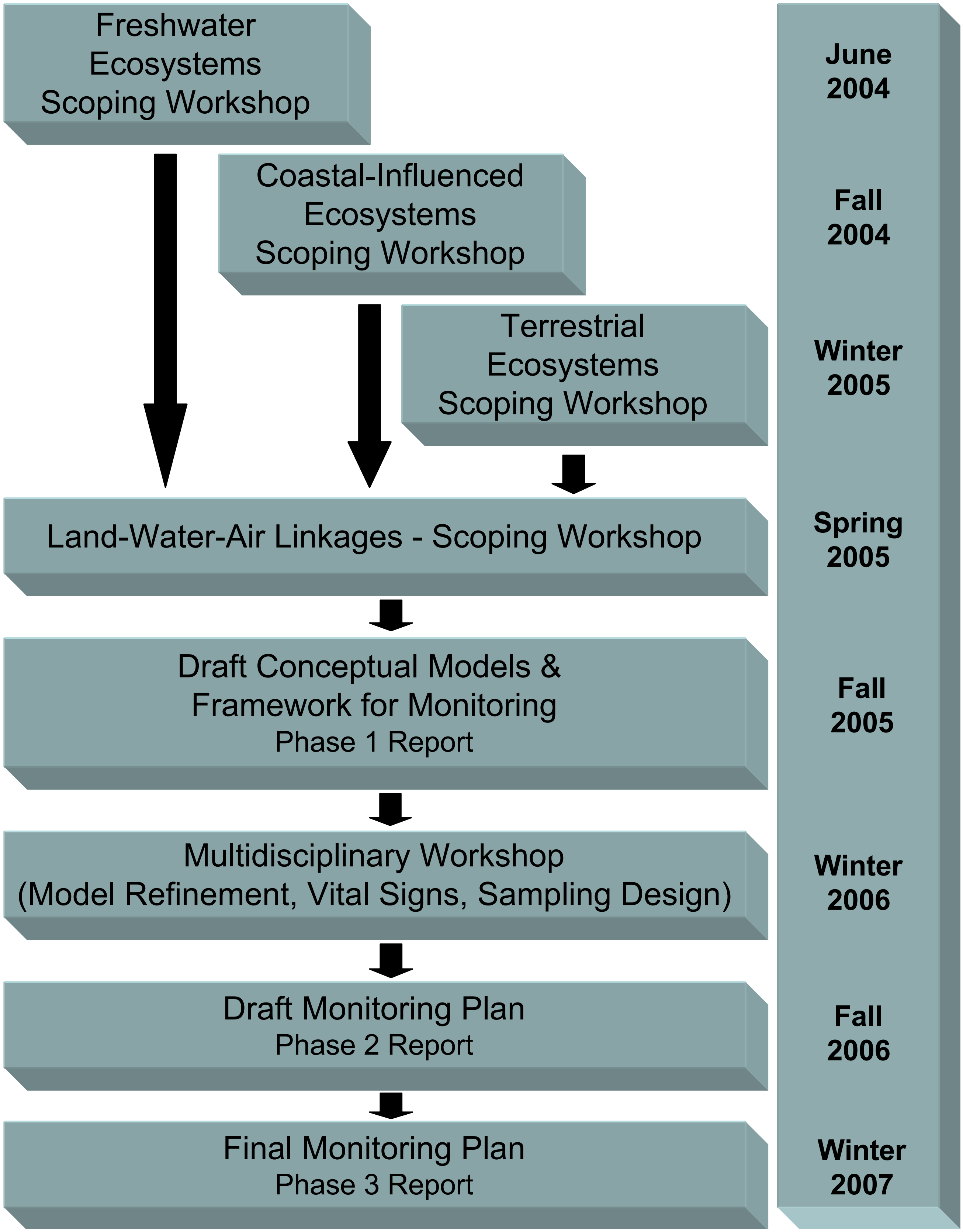


Figure 5. *Timeline for ARCN monitoring plan development.*

Framework for Conceptual Model Development

The four scoping workshops planned for the Arctic Network (ARCN) are designed to gain expert advice from, and initiate longer term consultation with, a broad array of scientists who have performed or are familiar with ecological research in Northern Alaska. **The input from these meetings will be used to develop a set of conceptual models of the natural and anthropogenic features and processes of the enormous areas included in the parks. These, in turn, will lead to a detailed plan for monitoring critical aspects of the environment of the parks.** It is expected that the data gathered in this program will contribute to responsible management of the parks so as to conserve their environmental integrity indefinitely. A valuable additional effect of this work should be to provide useful data and insights into the broader concerns of understanding and protection of the environment of the circumpolar north.

Long term monitoring is increasingly recognized as an essential tool for understanding and managing environments at many levels of geographical scale and human utilization. Since monitoring is essentially a system of sampling, it requires knowledge and judgment on the part of the people who design and carry out the monitoring program. Thus, long term monitoring is much more than the random gathering of data. Ideally, it is an evolving process that is guided by several concepts:

1. Efficiency: Monitoring must strive to get the maximum amount of useful information from a sampling system that is limited by factors such as cost, logistical concerns, and availability of trained personnel.
2. Relation to the broader world: Monitoring benefits from, and provides for, the exchange of useful information with comparable environments, even if they are being managed for different purposes, or have only minimal management programs/plans.
3. Flexibility: Monitoring plans must be able to incorporate new information and concepts and evolve with increased understanding of the ecosystems under study.
4. Scale: Monitoring deals with processes that take place over widely varying amounts of time and space. It must be designed to provide information on both local, often rapidly proceeding processes and those that occur over longer times and/or broader geographical areas.
5. Dynamism: Monitoring plans must recognize that ecosystems are never static, and that, even without anthropogenic impacts, complex changes will always be occurring.

The "Biomes"

The five western Arctic Parks/Preserves/Monuments all straddle the circumpolar ecotone that has traditionally been considered to be the boundary between the Arctic (tundra) biome and the boreal forest (taiga) biome. The most obvious manifestation of this boundary is the treeline, or timberline. It has long been recognized that the presence or absence of trees in most northern environments is correlated with climate, most specifically temperatures during the growing season. Much recent work has underscored the complexity of the relationship between the distribution of forest and summer temperature. It is clear, for example, that white spruce, the dominant timberline tree species in much of North America, reacts differently to changing climate than does Siberian larch, the timberline tree of most of northeastern Russia, or the various birch species that define timberline in northern Europe, Iceland and Greenland. While changes in the distribution of white spruce over time undoubtedly have relevance to the understanding of long term climatic change and its effect on northern Alaskan ecosystems, we need to be careful in making assumptions that the similar climatic factors will affect the distribution of tundra versus taiga ecosystems in other parts of the north.

The presence or absence of forest, although conspicuous, should not be overemphasized in discussions of what constitutes "arctic" versus "subarctic" ecosystems. Timberline is convoluted, often diffuse, and, on a local scale, clearly affected by non-climatic factors such as drainage. Also, climatic factors may act indirectly, as in controlling the presence of permafrost with a shallow active layer, which, in turn, affects soil moisture and drainage. Also, while certain elements of the forested ecosystem are clearly associated with white spruce (e.g. red squirrels, certain bark beetles) many other organisms are not confined to one or the other ecosystem. For them, the traditional boundary between arctic and subarctic is of little significance. We suggest that deemphasizing the traditional boundaries between arctic and boreal ecosystems in our region is appropriate when designing monitoring programs for our areas of interest. At the same time, we should recognize that changes in the distribution/abundance of many organisms, such as white spruce, in our study area may often be sensitive indicators of less visible changes in the environment.

Time Scale

Northern and western Alaska, perhaps even more than most regions of the world, has undergone enormous changes in the relatively recent geological past. In order to understand both the current array of organisms and the processes which maintain their interactions with the environment, it is necessary to approach them with a historical perspective in mind. In particular, we must recognize that the current environmental situation results from the interaction of processes that take place over greatly varying time scales. For purposes of discussion, we suggest the following time scales.

Long term geological: dealing with events that have occurred over millions of years, such as mountain building, the distribution of certain substrates, etc.

Late Quaternary: changes that have been important in the late Pleistocene and Holocene, especially the roughly 20,000 years since the last glacial maximum. These would include the termination of continental glaciation over much of the Northern Hemisphere, the submergence of huge areas of continental shelf, (especially the Bering Land Bridge). The extinction of many important megafaunal species, and the earliest activities of humans within our area.

Early-mid Holocene: changes primarily in vegetation and fauna associated with the emergence of modern ecosystems. Beginning of establishment of modern coastal features, such as the beach ridges of Cape Krusenstern and Cape Espenberg. Stabilization of many terrestrial features such as dunes and loess deposits.

Prehistoric: the emergence of the ancestors of the indigenous cultures of the area and the increasing importance of archaeological sites and materials as sources of data on the nature of the environment.

Historic-current: the time including the influence of western industrial society on the environments and peoples of our area, beginning soon after 1,800 C. E.

Short term: many of the phenomena with which we are concerned may be evident in the course of a very few years. They may be individual, recurrent, or cyclical.

Spatial Scale

Monitoring can usefully occur in situations as geographically limited as a single thaw pond, mountain slope or heavily utilized fishing location. It is likely to be most useful if observations on this scale are incorporated into a broader perspective. In a sense, all larger scale monitoring plans are composed of local sampling schemes, with information obtained collected and interpreted to provide a broader picture. Not only does monitoring within the parks in our study area provide information on the condition of the park itself, but it may also be highly significant on a scale as large as the whole circumpolar North. Thus, while the primary function of long term monitoring may be seen at one level as being useful in providing information to be used in managing parks, or areas within parks, we should not lose sight of the potential for NPS sponsored monitoring to affect our overall understanding of the northern environment. At the same time, it needs to be recognized that many of the changes that appear as local phenomena within the parks are, in fact, manifestations of much larger scale events which are expressed in a wide variety of ways over broad areas of the earth.

Data Gathering and Experimental Design

Efficient and useful monitoring depends on maintaining a balance between the random collection of massive quantities of data and focused sampling strategies designed to provide answers to highly specific questions. Random data collection creates problems of cost, storage and management, but it also may uncover unsuspected patterns of phenomena that would be missed in a more narrowly oriented program. It also may create a cache of information that may be useful in the future in totally unexpected ways. Narrowly focused research may rapidly provide understanding of critical processes and problems, and conclusions are easily formulated and transmitted. But it may allow important phenomena to "slip through the cracks," and it may lead workers to conclusions that turn out to have only limited applicability when an effort is made to apply them on a broad scale.

It is particularly important that monitoring plans be flexible enough to incorporate data that comes in from unusual or unexpected sources. This is especially true in wilderness Parks, since baseline data may be scanty and even anecdotal evidence for environmental change may be hard to come by. Under these circumstances, the use of proxy data derived from a variety of sources is critical. The best examples of this approach involve archaeological investigations and geological/paleoecological research. Excavations conducted by archaeologists often provide well-stratified and well-dated samples of biological elements of past environments. Careful analysis of the data from this source can provide detailed and reliable evidence for environmental change extending back for centuries or even millennia.

It is also important that monitoring plans be able to encompass and evaluate the significance of unusual and unique events such as insect outbreaks, fires, rapid changes in vertebrate populations or distributions, or exceptional floods.

In our scoping meetings we will be concerned with identifying the array of biological features and processes that might be usefully and appropriately monitored in ongoing efforts to protect and manage the five National Parks and Preserves in northwestern Alaska.

Bering Land Bridge National Preserve

Established: 1980, under ANILCA.

Size: 1.15 million hectares (2,457,000 acres)

Enabling Legislation

Bering Land Bridge National Preserve was established by the Alaska National Interest Lands Conservation Act (ANILCA) on December 2, 1980. As stated in ANILCA, Section 202 (2), the purpose of Bering Land Bridge is to:

> Bering Land Bridge National Preserve shall be managed for the following purposes, among others: To protect and interpret examples of arctic plant communities, volcanic lava flows, ash explosions, coastal formations, and other geologic processes; to protect habitat for internationally significant populations of migratory birds; to provide for archeological and paleontological study, in cooperation with Native Alaskans, of the process of plant and animal migration, including man, between North America and the Asian Continent; to protect habitat for, and populations of, fish and wildlife including, but not limited to, marine mammals, brown/grizzly bears, moose, and wolves; subject to such reasonable regulations as the Secretary may prescribe, to continue reindeer grazing use, including necessary facilities and equipment, within the areas which on January 1, 1976, were subject to reindeer grazing permits, in accordance with sound range management practices; to protect the viability of subsistence resources; and in a manner consistent with the foregoing, to provide for outdoor recreation and environmental education activities including public access for recreational purposes to the Serpentine Hot Springs area. The Secretary shall permit the continuation of customary patterns and modes of travel during periods of adequate snow cover within a one-hundred-foot right-of-way along either side of an existing route form Deering to the Taylor Highway, subject to such reasonable regulations as the Secretary may promulgate to assure that such travel is consistent with the foregoing purposes.

Purposes

- Protect and interpret examples of arctic plant communities, volcanic lava flows, ash explosions, coastal formations, and other geologic processes;
- Protect habitat for internationally significant populations of migratory birds;
- Provide for archeological and paleontological study, in cooperation with Native Alaskans, of the process of plant and animal migration between North America and the Asian Continent;
- Protect habitat for, and populations of fish and wildlife including, marine mammals, brown/grizzly bears, moose, and wolves;
- Continue reindeer grazing use;
- Provide for outdoor recreation and environmental education activities at Serpentine Hot Springs

Ecological Overview

Bering Land Bridge National Preserve occupies about one-third of the Seward Peninsula. The peninsula is approximately 320 km from east to west, and the greatest north to south distance is 240 km. The peninsula is the divide between the Pacific and Arctic oceans, with Norton Sound and Bering Sea to the south and Kotzebue Sound and Chukchi Sea to the north. The northernmost point of the peninsula, Cape Espenberg, extends just north of the Arctic Circle, and the westernmost point, Cape Prince of Wales, is only 88 km from Siberia.

The Seward Peninsula consists of a mixture of coastal plain, plateau, and mountain range. The coastal plain may be as wide as 40 km, with a variety of features along the sea: rocky headlands predominate in the south and west, while broad beaches, lagoons, offshore bars, inland wetlands, bays, and lakes are common along the north shore. Plateaus occupy a large portion of the interior of the peninsula, with elevations ranging from 180 to 900 m. These areas have broadly rounded hills and irregular topography, but they lack a well-defined system of ridges. The principal mountain ranges are the Kigluaiks, known locally as the Sawtooths (elevation 1,500 m) northwest of Nome, the York Mountains (elevation 1,100 m) in the west, and the Bendeleben Mountains (elevation 3,700 feet) in the center of the peninsula. The latter range forms the southern boundary of the preserve.

Climate

The climate of the Seward Peninsula and Bering Land Bridge National Preserve shows both maritime and continental influences. When surrounding marine waters are ice-free (mid June to early November), temperatures are moderate, humidity is high, and skies are typically cloudy, especially near the coast. Interior sections, even during this summer period, are somewhat drier and less cloudy, and therefore have greater heat buildup during daytime hours and a greater daily temperature change.

When offshore waters are frozen, both inland and coastal climates are more continental (i.e., drier, clearer, less windy). However, winter temperatures do not reach the extreme lows that are encountered in interior Alaska at this same latitude. Information from a few coastal stations (Nome, Wales/Tin City, Shishmaref, Teller and Kotzebue) has traditionally been used to characterize the preserve area. Climatological records for the preserve suggest somewhat colder winters (minimum January temperatures on the coast –l0 to -20oF, inland -60o F), and warmer summers (maximum July temperatures on the coast lower 50s, inland mid 60s) than in coastal areas.

Winds are moderate to strong year-round but are strongest during winter. Winter winds are predominately from the east, whereas summer winds and storm approach from the south and southwest. Typical monthly average wind speeds are 8-12 miles per hour (mph) year-round, but during stormy periods winds of 50-70 mph are possible.

Summer is the wettest period, with perhaps 7 to 10 cm of the 25 cm of annual precipitation being recorded. Snow, with a relatively low water content, averages about 127-152 cm per year.

Sea ice usually breaks up in early to mid June along the Chukchi Sea coast, although breakup can vary by several weeks. Even after breakup, ice lingers near the coast for a month or more and may be blown back to shore. Inland lakes and ponds thaw at varying times according to their depth, location, and exposure to winds.

Geology

The surface geology of the preserve is dominated by recent volcanic lava and ash flows, and by unconsolidated wind- or water-borne sediments. The five distinct lava flows around Imuruk Lake range in age from 65 million years (the Tertiary Kugruk volcanics) to as recently as 1,000 years (the Lost Jim flow). The older flows occurred on many separate occasions from a variety of vents and are now largely buried by the more recent flows as well as by wind-blown deposits of silt. The exposed volcanic rocks, all dark basaltic material, were originally rather smooth “pahoehoe” flows, but older flows have been severely shattered by frost action into large angular fragments. More recent flows are progressively less affected by frost fracturing and are little weathered, although virtually all exposed rock is covered by a nearly continuous mat of lichens.

A distinctly different series of volcanic events that consisted of small but violent explosions of steam and ash and small quantities of lava occurred on the preserve’s northern lowlands around Devil Mountain. These explosions created several large craters known as maars that are now filled with water. These features are rare at this latitude and differ from craters within volcanoes or calderas by having relatively low surrounding rims. The single or short-term explosions that created them simply blew out the original surface material, and there was no subsequent ash or lava to build up a cone or rim. The maars now known as the Devil Mountain Lakes and the Killeak Lakes are paired; the largest maar is White fish Lake.

Other than the exposed volcanic features and some bare ridges of exposed bedrock, most of the preserve is covered by an unconsolidated layer of sediment, including gravels, sand, and silt. Nearest the coast are layers of terrestrial sand and gravel and some marine sediments that represent a mix of river-borne materials and wind- and wave-transported beach materials left from earlier higher sea levels. Farther inland in the western part of the preserve are alluvial (river-borne) sediments derived from erosion of the higher mountainous regions south of the preserve. To the east, mantling the Imuruk volcanics and other bedrock, are extensive areas of fine wind-borne silts derived from Pleistocene glacial outwash plains now covered by the sea.

One specific geologic feature of significance is the small area of intrusive rock of Cretaceous age around Serpentine Hot Springs. Dozens of granitic spires and outcrops called tors are exposed, providing one of the relatively few dramatic geologic landscapes in the otherwise rolling and gentile topography of the preserve. The hot springs area is underlain by diverse, metamorphosed granite.

The most significant geological history theme of the preserve is the land bridge itself, which has intermittently been a dryland connection between the continents of Asia and North America. The land bridge was the result of lowered sea levels during the great ice ages, when vast amounts of water were tied up in continental glaciers. The land bridge chronology is not well understood, and opinions differ as to the actual times and duration of the connections. There was probably a connection in very ancient times, long before recorded glacial periods and before modern flora and fauna evolved. At that time some ancient plants may have been exchanged between the two continents. However, it was only during later connections (in the past 30,000 years) that human and recent Asian Mammals migrated to North America, and some species migrated from North America to Asia. At times the land bridge may have lasted 5,000 year or more, and covered a very broad area over which plant and animal life slowly expanded.

Glaciers at the time of the land bridge did not completely cover the Seward Peninsula. The peninsula's mountains were covered by glaciers on several occasions, resulting in typical glacial sculpturing and glacially derived sediments washed down to the lowlands. However, many lowlands remained free of glaciers, and there is no evidence in the preserve of glacial sculpturing or moraines and isolated rock piles. This implies that substantial ice-free areas during the time that the land bridge existed could have been continuously occupied by modern plants and animals. This raises the likelihood that lowlands now in the preserve were an important element in the land bridge story. Further study of these particular areas might locate specific evidence of earlier human and animal occupancy. Although some permanent ice fields still occur in the Bendeleben Mountains, there are no major glaciers anywhere on the Seward Peninsula.

Soils

Soils throughout the preserve are the typical peaty and loamy surface layers of arctic tundra lands over permafrost, with some areas (windswept ridges or recent volcanics) having very shallow or no soil development. Virtually all tundra soil types are rated as having medium to high erosion potential if they are distributed by roads, structures, or other activities like gardening or concentrated grazing of hoofed animals. No arable soils occur within the preserve.

Surface features of the preserve are much influenced by the existence of a continuous permafrost layer. The depth of the seasonally thawed active layer may vary from 0.3 – 3 m, depending on the type of surface (e.g., under a lake, gravel bar, or vegetated soil), while the perennially frozen layer below may be 4.5 m to over 60 m thick.

Permafrost is the cause of several topographic features. Thaw lakes form in depressions where water pools, causing local melting of the permafrost and continued expansion until adjacent lakes join to form large, irregularly shaped, shallow lakes. Pingos are ice-cored hills where the overlying soil is pushed up by the expansion of ice when permafrost reinvades a drained pond, or when ice or pressurized water is injected from below. Ice wedge polygons are extremely common on flat or gently sloping ground where soil in the upper active zone contracts during freezing, leaving symmetrical polygonal cracks which then fill with snow and eventually ice. Solifluction sheets form where the upper active layer, unable to drain down through the permafrost, becomes saturated and slips downslope.

Freshwater Resources

Extensive surface water is present in the northern half of the preserve, but the actual annual hydrologic budget is relatively small owing to the modest precipitation (25-38 cm). Five major rivers have substantial drainage basins within the boundary of the preserve, including: the Serpenitne, Cowpack, Nugnugaluktuk, Goodhope, and Noxapaga Rivers. Others have only a small portion within or along the boundaries of the preserve. These include the Inmachuk,Kugruk, Koyuk, and Kuzitrin.

Geothermal resources within the preserve include Serpentine Hot Springs. Discharge at the eastern spring is 2.2 L/s. The surface water temperature has been measured at 60-77oC. There are also several small springs at Pilgrim Springs.

There is a lack of basic information about fish diversity and distribution within BELA. The Alaska Natural Heritage Program (ANHP) identified 25 freshwater species with 9 documented. Information on fish presence in BELA appears to come mainly from reconnaissance type trips to specific locations or from incidental observations by biologists working on other taxa. While there has been considerable work on freshwater and marine/coastal fish in the region by the Alaska Department of Fish and Game, and others, very little of that work has occurred within the bounds of preserve.

Cape Krusenstern National Monument

Established: 1980, under ANILCA

Size: 227,000 hectares (560,000 acres)

Enabling Legislation

Cape Krusenstern National Monument was established in 1978 by presidential proclamation and then designated in the 1980 Alaska National Interest Lands Conservation Act (ANILCA, 16 USC 3101). Section 201(3) of ANILCA specifies that:

> The monument shall be managed for the following purposes, among others: To protect and interpret a series of archeological sites depicting every known cultural period in arctic Alaska; to provide for scientific study of the process of human population of the area from the Asian Continent; in cooperation with Native Alaskans, to preserve and interpret evidence of prehistoric and historic Native cultures; to protect habitat for seals and other marine mammals; to protect habitat for and populations of, birds, and other wildlife, and fish resources; and to protect the viability of subsistence resources. Subsistence uses by local residents shall be permitted in the monument in accordance with the provisions of Title VIII [of ANILCA].

Purposes

- Protect and interpret a series of archeological sites depicting every known cultural period in arctic Alaska;
- Provide for scientific study of the process of human population of the area from the Asian Continent;
- Preserve and interpret evidence of prehistoric and historic Native cultures, in cooperation with Native Alaskans;
- Protect habitat for seals and other marine mammals;
- Protect habitat for, and populations of, birds other wildlife, and fish;
- Protect the viability of subsistence resources.

Ecological Overview

Cape Krusenstern National Monument is in northwest Alaska, approximately 15 km northwest of Kotzebue. The monument is bordered by the Chukchi Sea to the west and Kotzebue Sound to the south. To the north and east are the river drainages of the Wulik and Noatak rivers.

The Monument is characterized by a coastal plain dotted with sizable lagoons and backed by gently rolling, limestone hills. On the east, the coastal plain meets an ancient sea cliff now mantled with tundra and blue-gray limestone rubble. Mount Noak (elevation 613 m), in the southeast portion of the monument is the highest point.

Cape Krusenstern's bluffs and its series of 114 beach ridges show the changing shorelines of the Chukchi Sea and contain a chronological record of an estimated 6,000 years of prehistoric and historic uses of northwest Alaska's coastline, primarily by native groups. The beach ridges along the monument's coast are known to contain exceptional resources for analyzing and interpreting the life cycles and technologies that ensured human survival in the arctic for the last 60 centuries.

Along the shoreline of the monument, shifting sea ice, ocean currents, and waves have formed, and continue to form, spits and barrier islands that are considered important for their scientific, cultural, and scenic values. These same oceanic forces are integral to the dynamic nature of the beach ridges and the annual openings and closings of lagoon outlets.

The broad plain between the hills of the cape and the hills in the northern sector of the monument is the tundra-covered bed of an Illinoisan glacier formed 250,000 years ago. It is also the former (now dry) course of the Noatak River. Pingos, eskers, frost polygons, thermokarst lakes, and ice lenses are tundra forms found in the monument. There are five major rivers of moderate size located in the Monument.

Climate

The climate of Cape Krusenstern is essentially maritime, influenced by the adjacent Kotzebue Sound and Chukchi Sea. Average daily temperatures in Kotzebue for the summer months (June, July, August) range from 7°C to 12°C, with temperatures occasionally as high as 29°C. The coldest months are from January until early March, when average daily temperatures range between –40°C and –18°C, with occasional lows in the –46°C range

Precipitation in Kotzebue is light, with only about 23 cm falling annually. More than half of this moisture falls between July and September, when a warm, moist movement of air from the southwest predominates. August is the wettest month, with a mean monthly precipitation of 5.74 cm. In total, precipitation occurs on an average of 110 days per year. Snowfall can occur during 10 months of the year, July and August usually being the exceptions. Annual snowfall averages less than 127 cm.

Winds are common in the monument, particularly along the coastline, with mean annual speeds of approximately 21 kmh. Mean monthly winds at Kotzebue are above 19 kmh from September until April and blow from the east. Cyclonic storms are frequent during this time and are often accompanied by blizzard conditions. Wind speeds can reach 161 kmh. Mean monthly wind speeds are comparable for the summer months but are from the west.

Geology

The geological framework of the northwest Alaska region was set in the late Paleozoic era, 600 million years ago. During the Triassic period, 225 million years ago, the site of the present Brooks Range was stabilized, and limestone and chert were formed. The process of mountain-building began during the mid-Jurassic period. 135 million years ago the land was intensely folded and faulted, and the existing east-west fault trends within the area were established. In the late Miocene time, 25 million years ago, seas flooded much of the formerly dry area of the Chukchi zone but retreated somewhat to form a land bridge between Siberia and Alaska. This land area was again overlain by seas about 4 million years ago and remained so until approximately one million years ago. The ice advances that occurred during Pleistocene time, one million years ago, caused a substantial drop in sea level and a consequent exposure of the land mass known as Beringia. The last retreat of the glaciers established the present sea level approximately 4,500 years ago.

Bedrock geology of the inland area north and east of the Krusenstern Lagoon includes rocks from Precambrian to Devonian times. Limestone, dolomite, chert, and phyllite are greatest in abundance. The southern extension of the Mulgrave Hills within the monument, known as the Tahinichok Mountains, contains dolomite, sandstone, shale, and limestone from the Devonian to Mississippian periods.

Glaciofluvial deposits are found over an area between the Noatak River to Kotlik Lagoon and between the Kilikmak and Jade Creek drainages. Within the monument this area was twice affected by glacial advances during the Pleistocene epoch. The first glacial advance occurred during the middle Pleistocene time. This event occurred between 250,000 and 1,250,000 years ago. The second, and more recent, glaciation correlates with the Illinoisan glaciation of the central United States and occurred between 125,000 and 250,000 years ago. During both periods of glaciation large glaciers extended down the Noatak River drainage, across the lowland area east of the Kotlik Lagoon, and left the present glaciofluvial deposits. The monument has not been glaciated for approximately 125,000 years. A unique feature within the monument is a recognizable Illinoisan glacial esker or gravel ridge marking the bed of a subglacial stream. An esker of this age (over 100,000 years old) is considered rare.

The coastal area of the monument north of Kotzebue Sound is a beach ridge plain, which has received sediments deposited by longshore currents over the last several thousand years. The primary purpose of the Cape Krusenstern National Monument is to protect and interpret this beach ridge complex, which contains archeological sites depicting every known cultural period in arctic Alaska over a 6,000-year period.

Soils

The major soil types associated with the monument include upland or mountain slope soils and those associated with the lowland areas nearer the coast. The lower slopes of the western Igichuk Hills and the Mulgrave Hills are covered with poorly drained, gravelly or loamy soils with a surface layer of peat. Depth to permafrost is variable. The upper slopes of these hilly areas have well-drained gravelly or loamy soils with a deep permafrost table.

Along the coastline of the monument and flanking Krusenstern, Kotlik, and other major lagoons are marine and alluvial deposits that form beaches, spits, and deltas. Soils of lowland areas along the coast are poorly drained, with a surface layer of fibrous peat and a shallow permafrost table. The peat layer ranges from 20 to 61 cm in depth.

Soil temperatures at nearby Kotzebue at a depth of 30 range from a high of 4°C during July and August to less than –9°C during most of February and March (Selkregg 1975). Because of the lag time between summer temperature highs near the surface and those at greater depths, the maximum depth of soils at more than –1.1°C is reached in Kotzebue in December.

Permafrost plays an important role in the topographic development and appearance of lands within the monument. The lowland areas of the monument are underlain by thick continuous permafrost. Permafrost can reach depths of 610 m, but generally reaches a maximum depth of 427 m within the inland portions of the monument. At nearby Kotzebue permafrost depths are generally less than 73 m because of saltwater intrusion at that depth (City of Kotzebue 1971).

A variety of permafrost features are evident within the monument, particularly in the lowland areas. These include thaw lakes, ice polygons, pingos, frost mounds, and solifluction lobes. Many of these features are caused by localized melting of ground ice, resulting in thermokarst formation.

Vegetation

The majority of the monument is characterized by moist tundra vegetation. In addition, wet and alpine tundra, boreal and salt-tolerant coastal communities exist in isolated areas. The moist tundra zone, encompassing virtually all lower slope and lowland areas inland from the coastline, is characterized by extensive cottongrass tussocks intertwined with mosses and lichens. Some areas are dominated by dwarf shrubs. Shrubs and other species in the moist tundra include willow (*Salix* spp.), dwarf birch (*Alnus crispa*), Labrador tea (*Ledum* spp.), Lapland rosebay (*Rhododendron lapponicum*), mountain alder (Alnus crispa), mountain avens (*Dryas* spp.), and saxifrages. In the wet tundra area along the southern boundary, mat vegetation is found. Grasses and sedges are dominant and include arrow grass (*Triglochin* spp.), pendant grass (*Arctophyla fulva*), bog rosemary (*Andromeda polifolia*), louseworts (*Pedicularis* spp.), and rushes (*Juncus* spp.).

At higher elevations (generally from 230 to 490 m) on windswept, well-drained, and rocky slopes of the western Igichuk Hills and the Tahinichok Mountains to the north is an alpine tundra community. Alpine tundra vegetation is sparse and consists of willow, heather (*Phyllodoce* family), and mountain avens in combination with grasses, sedges, herbs, and mosses. Lichens and saxifrages are common on drier areas.

Along the coast wave action and scouring by ice largely restrict plant growth to the lagoon side of the barrier islands and dunes. The succession of rows of ancient beaches at Cape Krusenstern, occurring as horizontally stratified ridges, are distinguishable by slight vegetational differences between the low ridges and their intervening swales. The vegetation of the coastal lagoons along the coast is abundant because of the high accumulation of nutrients in shallow waters.

Freshwater Resources

The lands within the monument are drained by a number of streams that flow from the uplands and empty into the Chukchi Sea or coastal lagoons. During the ice-free season, some of these streams and associated coastal lagoons provide important habitat for anadromous and freshwater fish populations, birds and terrestrial mammals. During the winter, streamflow at the surface ceases as waters freeze. In areas where substantial springs exist, water may continue to flow out at the surface and then freeze into successive thin sheets of ice forming aufeis areas. Both Jade and Rabbit creeks are subject to aufeis formation and have numerous channels and low intervening gravel bars.

Most of the streams in the monument are clear water streams, exhibiting low levels of suspended solids, turbidity, and nutrients. Water is highly oxygenated, moderately hard to hard, and of the calcium bicarbonate type. At the Red Dog Mine site outside the monument waters are naturally contaminated with cadmium, lead, and zinc. This contamination occurs because the ore in the ground is of sufficient quantity and concentration to alter the water as it passes over the ore deposit. There are several large lagoons and a few small lakes located within the monument.

Ground water information for the monument is currently very scarce. Development of wells for public water supplies could be very costly.

The Alaska Natural Heritage Program (ANHP) expected species list for freshwater/anadromous fish in the monument included 24 species, 18 of those have been documented. Their list of marine fish included 38 species, with only 8 species documented. Of primary importance to subsistence users are whitefish, including humpback whitefish (*Coregonus pidschian*), least cisco (*Coregonus sardinella*), Bering cisco (*Coregonus laurettae*), and broad whitefish (*Coregonus nasus*). They are taken seasonally at many locations, but Sheshalik Spit and Tukruk River are particularly important areas.

Arctic char (*Salvelinus alpinus*) are also important fish for local use, with quantities usually being taken at Sheshalik Spit. They are also found and spawn in Rabbit, Jade, and Kilikmak Creeks and in the Situkuyok River. Arctic grayling (*Thymallus arcticus*) are known to overwinter in the Rabbit Creek drainage and in the streams draining the Igichuk Hills. All five salmon species are found within Kotzebue Sound, but only the chum (dog) salmon (*Oncorhynchus keta*) is found in any major quantity. Spawning pink (humpy) salmon (*Oncorhynchus gorbuscha*) and chum salmon (Oncorhynchus keta) are found in the Wulik and Noatak Rivers, as are king (chinook) salmon (*Oncorhynchus tshawytscha*) and red (sockeye) salmon (*Oncorhynchus nerka*), Both chum and pink salmon most likely occur in Rabbit Creek.

Northern pike (*Esox lucius*) are present in many streams in the monument south of Krusenstern Lagoon and east to Sheshalik Spit. Occasionally burbot (*Lota lota*) are found in the same areas (ADF&G 1978). Dolly Varden (*Salvelinus malma*) are known to spawn in Rabbit Creek. Herring (*Clupea* spp.) spawn in Krusenstern Lagoon and in the shallow coastal waters north of Sheshalik Spit, where sheefish (*Stendous leucichthys*) also overwinter. Other species that are occasionally used for human and dog food include: saffron cod (*Eleginus gracilis*), arctic cod (*Boreogadus saida*), rainbow smelt (*Osmerus mordax*), starry flounder (*Platichthys stellatus*), 4-horned sculpin (*Myoxocephalus quadricornis*), nine-spined stickleback (*Pungitius pungitius*), and herring. Some crabbing in ice-free periods has been done, but only with very limited success.

Gates of the Arctic Park and Preserve

Established: 1980, under ANILCA

Size: 2.9 million hectares (7,052,000 acres)

Enabling Legislation

Gates of the Arctic Park and Preserve was established by the Alaska National Interest Land Conservation Act (ANILCA), Public Law 96-487. Section 201(4)(a) of this act directs the following:

> The park and preserve shall be managed for the following purposes, among others: To maintain the wild and undeveloped character of the area, including opportunities for visitors to experience solitude, and natural environmental integrity and scenic beauty of the mountains, forelands, rivers, lakes, and other natural features; to provide continued opportunities, including reasonable access, for mountain climbing, mountaineering, and other wilderness recreational activities; and to protect habitat for and the populations of, fish and wildlife, including, but not limited to, caribou, grizzly bears, Dall sheep, moose, wolves, and raptorial birds. Subsistence uses by local residents shall be permitted in the park, where such uses are traditional, in accordance with the provisions of title VIII.

Purposes

- Maintain the wild and undeveloped character of the area, including opportunities for visitors to experience solitude, and the natural environmental integrity and scenic beauty of the mountains, forelands, rivers, lakes, and other natural features;
- Provide continued opportunities including reasonable access for mountain climbing, mountaineering, and other wilderness recreational activities;
- Protect habitat for and populations of fish and wildlife, including, but not limited to, caribou, grizzly bears, Dall sheep, moose, wolves, and raptorial birds.

Ecological Overview

Gates of the Arctic Park and Preserve is located just north of the Arctic Circle in the northernmost stretch of the Rocky Mountains, the Brooks Range. The entire Noatak River drainage, the headwaters of which are in the park, is internationally recognized as a biosphere reserve in the United Nation's "Man in the Biosphere" program.

Two sites within the park and preserve were designated national natural landmarks in April 1968--Arrigetch Peaks (15135 ha) and Walker Lake (73297 ha). In addition, several other sites have been identified as potential natural landmarks: Anaktuvuk River; Castle Mountain; Fortress Mountain; Monotis Creek; Noatak, Sagavanirktok-Itkillik, Alatna, Nigu and Killik River headwaters; Anaktuvuk, Cocked Hat and Limestone Mountains; Kipmuik, Kurupa, Wild and Cascade Lakes; Hickel Highway; Mount lgikpak; North Fork Koyukuk Pingos; Redstar Mountain; and Reed River Hot Springs.

Climate

The central Brooks Range has long winters and relatively short cool summers. The entire region receives continuous sunlight during the summer for at least 30 days. Precipitation on the south side of the Brooks Range averages 30- 46 cm in the west and 20- 30 cm inches in the east. Snow falls 8 or 9 months of the year, averaging 152- 203 cm. The average maximum and minimum July temperatures are approximately 18° to 21°C and 6° to 8°C, respectively. Average maximum and minimum January temperatures are approximately -18° to -23°C and -29° to -34°C. Thunderstorm activity is common during June and July, and generally June through September is the wettest time of year. Prevailing winds are out of the north.

The north side of the Brooks Range has an arctic climate. The influences of the Arctic Ocean and North Slope weather patterns predominate, especially during the summer months. Mean annual temperatures are colder than on the south side. Average maximum and minimum February temperatures are –21° to -23°C. The warmest month, July, has average maximum temperatures of 13° to 18°C and average minimum temperatures of 32° to 47°C. Precipitation is extremely light, about 13-26 cm a year. Average annual snowfall ranges from 89 to 127 cm. Prevailing winds come from the east in summer and west in the winter months.

Geology

The central Brooks Range is a remote area of rugged, glaciated east-trending ridges that rise to elevations of 1,220 to 2,438 m or more. This range is part of the Rocky Mountain system that stretches completely across the northern part of Alaska. Gates of the Arctic National Park and Preserve spreads across three physiographic provinces: Arctic Foothills, Arctic Mountain, and Western Alaska (NPS, USDI 1974). Two primary mountain ranges make up the central Brooks Range--the Endicott and Schwatka mountains. Several episodes of uplift, deformation, and intrusion have produced complex patterns of folding, fracturing, and overlapping thrust fault blocks. Uplift, erosion, and heavy glaciation account for the rugged mountain profiles and U-shaped valleys evident today. Metamorphic rocks, primarily quartz mica schist and chloritic schists, belt the south flank of the range. There are also a few small bodies of marble and dolomites. Granitic intrusion created the rugged Arrigetch Peaks and Mt. Igikpak areas.

Four major glaciations have been recognized within this region of the Brooks Range. The first glaciation (Anaktuvuk River) took place more than one-half million years ago. The second (Sagavanirktok River) is thought to be broadly equivalent to the Illinoian glaciation of central North America. The last two glacial periods (Itkillik and Walker Lake) are thought to correlate with the Wisconsin advance in central North America (Geological Survey, USDI 1979). Glaciers were generated at relatively high altitudes near the crest of the range during the more extensive glaciations. Ice flowed from these sources southward through the major valley systems to terminate at and beyond the south flank of the range. Terminal glacial moraines created dams that formed large lakes along the southern foothills.

The primary metallic minerals found within the region include copper, gold, lead, and zinc. The major known deposits of minerals occur in a schist belt that generally lies south and west of the park in the Ambler mining district and may extend into the unit.

Soils

Soils within the park are highly variable, depending on topography, drainage, aspect, fire history, permafrost, and parent material. The classification used by the U.S. Department of Agriculture, Soil Conservation Service (1979) indicates that most of the park lies within a

zone characterized by rough mountainous land with thin, sandy soils on hilly to steep topography. The soils are often composed of poorly drained, very gravelly loam on hilly moraines and south-facing colluvial slopes. A thin peaty mat is underlain by sandy loams and occasional lenses of permafrost.

Lower elevation benches and rolling uplands are covered by a gray to brown silty loam overlaid by a peaty organic layer that varies in depth depending on the local environment. The, soil surface is irregular, with many low mounds, solifluction lobes, and tussocks.

Soils in the park overlie thick continuous permafrost zones that are sometimes located within a few inches of the surface. These soils have been subjected to millions of years of gradual downslope creep by frost-shattered rock and to a constant seasonal pattern of freezing and thawing. Lower elevation sediments have combined over time with windblown silts, river and glacial deposits, and peat accumulations. The processes of frost heaving and sorting, ice lens or wedge formation, and stream erosion have worked these soils into a complex mosaic of roughly textured tundra polygons, pingos, oxbows, and terraces. Almost totally underlain by permafrost, the soils adjacent to the valley floodplains are highly susceptible to any kind of ground disturbance, since melting of the permafrost can result in subsequent soil collapse.

The northern area of the park, primarily the upper Noatak River drainage, contains poorly drained soils formed from very gravelly glaciofluvial material derived from limestone rock in the surrounding mountains. A few well-drained soils are found in very gravelly, nonacid and calcareous drift on hilly moraines. Fibrous peat soils are located in shallow depressions on terraces.

Vegetation

Three major vegetation associations occur in the park and preserve--the taiga (boreal forest), tundra, and shrub thicket. Alpine and moist tundra are the most extensive vegetation types. The taiga reaches its northernmost limit along the southern flanks of the Brooks Range within the park.

Alpine tundra communities occur in mountainous areas and along well-drained rocky ridges. The soils tend to be coarse, rocky, and dry. A community of low, mat-forming heather vegetation is characteristic of much of the area. Exposed outcrops of talus sustain sparse islands of cushion plants, such as moss campion (*Silene acaulis*) and saxifrage, interspersed with lichens. The low-growth forms of these plants protect them from snow and sand abrasion in this windswept environment. Other important plants include Dryas spp., willows (*Salix* spp), heather (*Phyllodoce* family), and lichens, especially reindeer lichens. Several species of grasses, sedges, and herbs are also present.

Moist tundra is found in the foothills and in pockets of moderately drained soils on hillsides and along river valleys. Cottongrass tussocks (*Eriophorum* spp.), 15–25 cm high, predominate the landscape.

Mosses and lichens grow in the moist channels between the tussocks. Other plants include grasses, small shrubs (dwarf birch [*Betula nana*], willow, and Labrador tea [*Ledum* spp]), and a few herbs.

The extensive forest cover found south of the mountains thins into scattered stands of spruce mixed with hardwoods that follow the river valleys north into the mountains to an elevation of about 640 m. This spruce-hardwood forest takes two forms. White spruce (*Picea glauca*) usually in association with scattered birch (*Betula papyrifera*) or aspen (*Populus tremuloides*) is commonly found on moderate south-facing slopes. Heaths, such as bearberry (*Arctostaphylos* spp), crowberry (*Empetrum nigrum*), Labrador tea, blueberry (*Vaccinium uliginosum*), and cranberry (*Vaccinium vitis-idaea*) are common, as are willows. Lichens and mosses cover the forest floor along with a variety of herbs. Some large, purer stands of white spruce occur along rivers such as the Kobuk; balsam poplar (*Populus balsamifera*) are found with spruce in such areas. On the north-facing slopes and on poorly drained lowlands, black spruce (*Picea mariana*) is predominant. The understory in these areas is spongy moss and low brush.

As the tree line is approached, the forest thins out until spruce are scattered among the shrub thicket community. In one type of shrub thicket, dwarf and resin birch (Betula resinosa), willows, and alder (Alnus spp.) may be extremely dense or open and interspersed with reindeer lichens, low heath-type shrubs, or patches of alpine tundra. Alder is usually found on moister sites and birch on drier sites. Such shrub thickets typically occur up to 914 m in elevation. A second type of shrub thicket association occurs along the alluvial plains and gravel bars of braided or meandering streams. Willows and alders predominate and are associated with dwarf fireweed (Epilobium latifolium), horsetails (Equisetum spp.)), prickly rose (Rosa acicularis), and other herbs and shrubs. These thickets develop rapidly in floodplains that are newly exposed after breakup and spring flooding.

Freshwater Resources

Tributaries of four major river systems originate in the park and preserve. To the north the Nigu, Killik, Chandler, Anaktuvuk, and Itkillik rivers drain to the Colville River. The Noatak River flows west and the Kobuk River southwest, both from the headwaters in the western part of the park. The John, Alatna, and North Fork of the Koyukuk rivers drain south to the Yukon River. Six rivers within the park boundary are designated as "Wild and Scenic": Alatna, John, Kobuk, Noatak, North Fork of the Koyukuk and Tinayguk Rivers. The John River may have some water quality issues arising from the village of Anaktuvuk Pass. The Middle Fork and North Fork of the Koyukuk may show some effects from placer mining.

Three warm springs are located within the park and preserve. The Reed River spring is located near the headwaters of the Reed and had a measured water temperature of 50°C at the warmest pool (NPS, USDI 1982). A warm spring is also located on the lower Kugrak River and another near the Alatna River.

The expected Species list for the fishes of GAAR developed by the Alaska Natural Heritage Program included 16 species, of which 14 were documented (88%). More common fish species include arctic grayling (*Thymallus arcticus*), lake trout (*Salvelinus namaycush*), northern pike (*Esox lucius*), arctic char (*Salvelinus alpinus*), whitefish (*Coregonus* spp.), sheefish (*Stendous leucichthys*), salmon (*Oncorhynchus* spp.), long-nosed sucker (*Catostomus catostomus*), burbot (Lota lota), nine-spined stickleback (*Pungitius pungitius*), and slimy sculpin (*Cottus cognatus*).

The Kobuk and Koyukuk rivers are the major chum salmon spawning streams. Sheefish also spawn in the Kobuk. These fish, along with the whitefish, are the most important subsistence fishes. Some lake trout and arctic char are also taken from lakes for subsistence use. Recreational fishing is primarily for arctic grayling, arctic char, sheefish, and lake trout.

Kobuk Valley National Park

Established: 1980

Size: 692,000 hectares (1,710,000 acres)

Enabling Legislation

Kobuk Valley National Park was established by the Alaska National Interest Land Conservation Act (ANILCA), Public Law 96-487. Section 201(6) of this act directs the following:

> Kobuk Valley National Park shall be managed for the following purposes, among others: To maintain the environmental integrity of the natural features of the Kobuk River Valley, including the Kobuk, Salmon, and other rivers, the boreal forest, and the Great Kobuk Sand Dunes, in an undeveloped state; to protect and interpret, in cooperation with Native Alaskans, archeological sites associated with Native cultures; to protect migration routes for the Arctic caribou herd; to protect habitat for, and populations of, fish and wildlife including but not limited to caribou, moose, black and grizzly bears, wolves, and waterfowl ; and to protect the viability of subsistence resources. Subsistence uses by local residents shall be permitted in the park in accordance with the provisions of title VIII. Except at such times when, and locations where, to do so would be inconsistent with the purposes of the park, the Secretary shall permit aircraft to continue to land at sites in the upper Salmon River watershed.

Purposes

- Maintain the environmental integrity of the natural features of the Kobuk River Valley, including the Kobuk, Salmon, and other rivers, the boreal forest, and Great Kobuk Sand Dunes, in an undeveloped state;
- Protect and interpret, in cooperation with Native Alaskans, archeological sites associated with Native cultures;
- Protect migration routes for the Arctic caribou herd;
- Protect habitat for, and populations of, fish and wildlife including but not limited to caribou, moose, black and grizzly bears, wolves, and waterfowl;
- Protect the viability of subsistence resources.

Ecological Overview

The boundaries of Kobuk Valley National Park run along the ridges of a set of mountains that form a circle. These mountains define and enclose the Kobuk Valley. The Kobuk River cuts across the southern third of this circle. The encircling mountains are the Baird Mountains, to the North which are the western most extension of the Brooks Range, and to the south are the Waring Mountains

The Kobuk River begins in the central Brooks Range. In the river's midsection, as it passes through the Kobuk Valley, it is wide, slow moving, and clear. Its banks and bottom are sandy. Lively clearwater tributaries to the Kobuk have their headwaters in the Baird Mountains. These are the Akillik, the Hunt, the Kaliguricheark, the Tutuksuk, the Salmon, and the Kallarichuk. After tumbling over rocky bottoms in the mountains, they slow as they cross the nearly level floor of the Kobuk Valley. Their waters take on a slight brownish color from the peat and other organic matter that overlay the valley floor. They enter the Kobuk through low breaches in the sandy banks. Only slow moving creeks enter the Kobuk from the south.

Trees approach their northern limit in the Kobuk Valley, where forest and tundra meet. Vast expanses of tundra cover the valley in some locations, while forests cover other better-drained portions of the valley. In some locations sparse stands of spruce, birch, and poplar grow above a thick and brittle ground cover of light-colored lichens, creating a bright and easily traversed forest.

Sand created by the grinding of glaciers has been carried to the Kobuk Valley by winds and water. Large sand dunes lie on the south side of the Kobuk River. These are the Great Kobuk Sand Dunes, the Little Kobuk Sand Dunes, and the Hunt River Dunes. Older, vegetated dunes cover much of the southern portion of the valley.

Caribou pass through the valley on their spring and fall migrations. In the spring, caribou come over the Waring Mountains heading north, cross the Kobuk River, and move into north-south passes in the Baird Mountains. They continue on to the North Slope for calving. In the fall the migration is reversed. Caribou cross the valley in such great numbers and on such regular routes that they form trails that are obvious from the air and ground. Many caribou cross the Kobuk River at Onion Portage on the eastern side of the valley.

Native people have lived in the Kobuk Valley for at least 12,500 years. This human use is best recorded at the extensive archeological sites at Onion Portage. Each fall for thousands of years, people have waited at Onion Portage for the caribou to arrive. Caribou trails pass through the middle of this cluster of housepits and other remains of these native peoples. Numerous other prehistoric villages and campsites have been discovered in the Kobuk Valley.

Climate

Average temperature and precipitation for the park are estimated from the closest weather stations in Kotzebue, Noorvik and Kobuk. In July, mean temperatures range from 11–14°C. Mean temperatures in January range from –19 to –22°C.

The Bering and Chukchi seas provide the primary source of precipitation to northwest Alaska during the summer months, when the waters are ice free and prevailing winds blow from the east across the landmass, and lower precipitation levels occur. Coastal and lower elevation areas in the southwest portion of the region receive approximately 20–25 cm of precipitation annually. Higher inland areas to the east receive 40 to 76 cm of precipitation. Snowfall ranges between 114 cm annually in the southwest to more than 254 at higher elevations in the east.

Freezing of rivers generally occurs from early to mid-October and breakup occurs in mid to late May. At Kotzebue freeze-up occurs about October 23 and breakup about May 31. At Kiana, on the Kobuk River, these events occur on about October 18 and May 18, respectively.

Geology

Three general landscape types exist within Kobuk Valley National Park: the Baird Mountains, the Waring Mountains, and the Kobuk Valley lowlands (floodplain and terraces). The Baird Mountains are a western extension of the Brooks Range. The Baird Mountains separate the Noatak and Kobuk river drainages. They rise abruptly from the lowland on the south to heights of 762 to 1,450 m. The Baird Mountains consist primarily of Paleozoic sedimentary and older metamorphosed rocks that have been thrust-faulted and folded. Rock types are shale, conglomerate, sand stone, and metamorphosed limestone. On the southern flanks of the Baird Mountains, within the park, sediments metamorphosed into phyllite and schist are found. Jurassic to Permian volcanic and intrusive rocks are also present.

The Waring Mountains, to the south of the Kobuk River, are broadly folded, northeast-trending mountains primarily of Cretaceous sedimentary rock. Rock types include graywacke, sand stone, siltstone, shale, and conglomerate. The peaks of this range are generally less than 609 m high.

The Kobuk River runs through the lowland between the Baird Mountains and Waring Mountains. This area is largely covered by glacial drift and alluvial deposits, including clayey till , outwash gravel, sand, and silt. The underlying bedrock of the lowlands is composed of Cretaceous sedimentary rocks such as shale, sandstone, siltstone, conglomerate, and graywacke.

Although there are currently no glaciers within the park, at least five major Pleistocene glaciations have been identified in northwest Alaska. The greatest of these glacial events occurred during Illinoisian time when glaciers extended west to the Baldwin Peninsula. The two earlier glaciations, the Kobuk and Ambler glaciations, covered large areas of the Kobuk and Selawik valleys and the drainages of the Baird Mountains. The three later glaciations were restricted to portions of the Schwatka Mountains east of the park.

During the interglacial period between the Kobuk and Ambler glaciations, glacio-fluvial deposits on river bars and outwash plains were worked by strong easterly winds. The down-valley movement of large volumes of silt and sand created dune fields, which cover an area of approximately 90,000 ha. Most of this dune area is currently vegetated by tundra and forest, except for the three active dunes—the Great Kobuk Sand Dunes the Little Kobuk Sand Dunes, and the Hunt River Dunes. These active dunes cover approximately 8,300 ha. The Great Kobuk Sand Dunes lie less than 3 km south of the Kobuk River, immediately east of Kavet Creek. The Little Kobuk Sand Dunes lie about 8km south of the Kobuk River in the southeastern portion of the park. The Hunt River Dunes are located on the south bank of the Kobuk River across from the mouth of the Hunt River.

The Great Kobuk Sand Dunes display a complete and readily observable sequence of dune development, from the U-shaped, concave dunes with vegetative cover in the eastern portion of the field, to the crescent-shaped, unvegetated brachan dunes, which stand over 30 m high, in the western portion. It is the largest active dune field in arctic North America.

Lowland areas in the Kobuk River drainage are underlain by discontinuous permafrost with a maximum depth to its base of 118 m. The Baird Mountains to the north are underlain by continuous permafrost, while the Waring Mountains to the south have thin to moderately thick permafrost. A variety of permafrost features are evident within the park. These features can be collectively referred to as "thermokarst topography," and include thaw lakes, ice wedges, polygons, pingos, frost mounds, and solifluction lobes.

Numerous large mineral deposits occur about 48 km to the east of the park in the vicinity of Cosmos Mountain and the Schwatka Mountains. Mineral terranes occur in the park through most of the Baird Mountains. The Salmon and Tutuksuk River watersheds are reported to have unusual (anomalous) concentrations of copper, lead, and zinc. A mineral terrane thought to be favorable for the occurrence of nickel, platinum and chromium deposits, runs along the base of the Baird Mountains, from about the center of the park, east along the base of the Schwatka Mountains. Despite the known or suspected mineral terranes that occur within the park, no significant mineral deposits have been identified in the park (AEIDC 1979 and 1982).

Jade is mined on the southern slopes of the Jade Mountains to the east of the park. Jade boulders are removed from the surface of talus slopes and are transported during the winter to the Kobuk River, where they are stockpiled to be taken by barge to Kotzebue after breakup. The boulders are cut and the jade is fashioned into jewelry and other items in Kotzebue.

Thin seams of subbituminous and bituminous coal (generally less than 0.6 m thick) occur along the Kobuk River, between the village of Kiana and the Pah River, 96 km east of the park. Small outcrops of coal can be seen along the Kobuk River between Trinity Creek (6.4 km downstream from the park's western boundary) and the Kallarichuk River within the park. Coal deposits have also been reported along a tributary at the Kallarichuk River.

Soils

Soils on the higher slopes of the Baird Mountains consist of thin layers of highly gravelly and stony loam. Where soils accumulate in protected pockets on steeper mountain slopes, they support mosses, lichens, and some dwarf shrubs. Soils on the broad lowlands within the park are generally poorly drained, with a peaty surface layer of variable depth and a shallow depth to permafrost. Texture within these soils varies from very gravelly to sandy or clayey loam.

An area of approximately 90,000 ha south of the Kobuk River is composed of well-drained, thin, strongly acidic soils. These are vegetated and unvegetated sand dune fields. The unvegetated Great Kobuk and Little Kobuk sand dune fields are comparable in soil type and texture to the vegetated portions of the dune fields, but they are rated as having high erosion potential due to scarcity of vegetation.

The floodplains of the Kobuk River and its tributaries, including the Hunt, Akillik, and Salmon rivers, are characterized by silty and sandy sediments and gravel. Soil erosion along the banks of the Kobuk River can be significant. Most bank erosion occurs during spring breakup when high volumes of water and ice scour the riverbanks and carry sediment downstream. In places where river water comes into contact with permafrost in river banks, thermal erosion can occur. Additional erosion can occur during high precipitation in the summer months. Along the Kobuk River evidence of the erosion and slumping of sandy riverbanks is readily observable at numerous locations.

Vegetation

In Alaska the boreal forest generally reaches its northwestern limits on the south slopes of the Baird Mountains, which divide the valleys of the west-flowing Noatak and Kobuk rivers. While the Noatak basin is largely vegetated with tundra, the Kobuk Valley is partially forested and is representative of the broad transition zone between forest and tundra. Because the Kobuk Valley is in the transition zone between the more interior Alaska forested areas and the more northern and western tundra areas, both forest and tundra vegetation types are broadly represented in the park. The 40-km-wide valley floor between the Waring Mountains on the south and the higher Baird Mountains on the north is characterized by treeless tundra expanses between forested lands. Forests occur on better drained areas along stream courses and on higher ground. This alternating tundra and forest pattern forms a mosaic across the valley. Spruce and balsam poplar grow in the lower and middle reaches of the river valleys that extend into the Baird and Waring mountains. Willow and alder thickets and isolated cottonwood grow up to the headwaters of rivers and streams. Alpine tundra covers the slopes and ridges of the mountains.

Botanical studies have resulted in the identification of a number of basic vegetation types in Kobuk Valley National Park. Four types of forest communities exist. White spruce forests generally occur on well- drained slopes and stream banks below 304 m in elevation. More open spruce woodlands occur in valley lowlands and flats. Open, lichen-carpeted woodlands grow on stabilized sand dunes and coarse glacial deposits; and cottonwood forests grow on gravel bars along streams (Melchior, et al. 1976).

Three types of shrub communities have been identified within the park. Willow scrub occurs on gravel bars and stream and lake margins; Alder scrub occurs on drainageways and upper mountain slopes; and willow, alder, and young spruce occur on old burn sites (Melchior, et al. 1976).

The broad, relatively flat floor of the Kobuk Valley is covered by large treeless areas of tussock tundra and low, heath-type vegetation. Heath vegetation occurs in poorly drained areas in flats in the valley and mountains and is composed in part of dwarf birch, dwarf blueberry, Labrador tea, and mosses. Tussock tundra occurs on flat valley floors and consists principally of dwarf birch, and Labrador tea and clumps of sedges. Vegetated upper mountain slopes, ridges, and peaks are covered by dwarf birch, blueberry, and other species of alpine tundra vegetation (Melchior, et al. 1976).

Lightning and human-caused fires have affected the vegetation over much of the Kobuk Valley. Large areas of forest and tundra have burned. Plants that invade or become dominant in recently burned areas include willows, alders, and fireweed. In 1981 a fire burned the spruce woodland immediately west of the Great Kobuk Sand Dunes.

The three active sand dunes in the park (totaling approximately 8,300 ha are sparsely vegetated. Two older dune fields in and to the east of the park (totaling approximately 90,000 ha) are currently vegetated, primarily with open woodlands. The phases of plant succession of the dune fields can be observed in the park, with some areas of the dunes having little or no vegetation and other areas heavily covered by white spruce, willows, and lichens.

Freshwater Resources

The Kobuk and Noatak rivers are the largest rivers within northwest Alaska and together drain an area of 63,654 km2. The Kobuk River drains 31,028 km2 and has an estimated annual average flow of 438 m3 per second. The river is 558 km long and 0.30 to 0.45 km wide in its lower and middle reaches. It is clear, except at the highest water stage, and has a generally sandy or gravelly bottom. The river is 15 m above sea level at the eastern boundary of Kobuk Valley National Park. Meander scrolls, oxbow bends, and sloughs are abundant along the river's course. The floodplain of the Kobuk River varies from 1.6 to 12.8 km wide.

The major tributaries of the Kobuk River within the park are the Kallarichuk, Salmon, Tutuksuk, Kaliguricheark, Hunt, and Akillik rivers. All have their headwaters in the Baird Mountains, and all are entirely undeveloped. The Salmon has been designated as a wild river in the wild and scenic river system; it drains 1,709 km2. The Tutuksuk, east of the Salmon River, is 48 km long and drains 906 km2. The Hunt River, in the eastern portion of the park, is 64 km long and drains 1,592 km2.

Numerous small lakes and ponds lie within the Kobuk River watershed, particularly in the lowlands along the river. Some ponds and lakes formed as detached oxbows of the meandering river, while others formed where permafrost has melted and caused depressions. Some small lakes are on the north slopes of the Waring Mountains, and some cirque lakes are in the Baird Mountains.

Total dissolved solids in most streams in the region are generally less than 200 milligrams per liter. The Kobuk River at Kiana contains less than 250 milligrams per liter of dissolved solids – magnesium and bicarbonate are the most prevalent dissolved solids, and calcium and chloride are found in smaller quantities. The concentrations of dissolved solids increase from the headwaters of the Kobuk to its mouth at the Hotham Inlet. The free-flowing waters of northwest Alaska have the lowest yield of sediment in the state, due largely to low topographic relief, lack of glaciers, low levels of runoff, and the stabilizing effect of permafrost on soils.

The expected species list developed by the AHNP included 22 expected species, with 16 species documented (72%). A review of the available literature suggests that fish in KOVA are less well-known than in NOAT. Most of the prior work has been conducted by the Alaska Department of Fish and Game relative to commercial and subsistence fisheries. The pre-ANILCA expedition of Melchior (1976) included some fish inventory work in KOVA, and reviewed the literature existing at that time.

Although all five species of Pacific salmon occur in the waters of the region, only chum (*Oncorhynchus keta*), king (*Oncorhynchus tshawytscha*), and pink (*Oncorhynchus gorbuscha*) salmon occur in the drainages of Kobuk Valley National Park. Chum salmon is the most abundant species of salmon in the region and is the most significant species for commercial and subsistence fisheries. The Salmon and Tutuksuk rivers are major spawning and production tributaries of the Kobuk River for chum salmon. Arctic grayling (*Thymallus arcticus*) and arctic char (*Salvelinus alpinus*) are distributed throughout the waters of the park. Inconnu, or sheefish (*Stendous leucichthys*), inhabit the Kobuk and Selawik rivers. Sheefish overwinter in Hotham Inlet and Selawik Lake. After ice breakup, sheefish move upriver to spawning areas. Known spawning areas are located upriver from the village of Kobuk. Within the park sheefish (*Coregonus* spp.), inhabit the Kobuk River. Northern pike (*Esox lucius*), whitefish, burbot (*Lota lota*), long-nosed sucker (*Catostomus catostomus*), slimy sculpin (*Cottus cognatus*), and least ciscos (*Coregonus sardinella*) inhabit rivers and lakes in the region and park.

Noatak National Preserve

Established: 1980, under ANILCA

Size: 2.61 million hectares (6,460,000 acres)

Enabling Legislation

Noatak National Monument was created by presidential proclamation in December 1978. On December 2, 1980, through the enactment of the Alaska National Interest Lands Conservation Act (ANILCA, Public Law 96-487) the monument became Noatak National Preserve. Section 201(8) of this act specifies that:

> The preserve shall be managed for the following purposes, among others: To maintain the environmental integrity of the Noatak River and adjacent uplands within the preserve in such a manner as to assure the continuation of geological and biological processes unimpaired by adverse human activity; to protect habitat for, and populations of, fish and wildlife, including but not limited to caribou, grizzly bears, Dall sheep, moose, wolves, and for waterfowl, raptors, and other species of birds; to protect archeological resources; and in a manner consistent with the foregoing, to provide opportunities for scientific research. The Secretary may establish a board consisting of scientists and other experts in the field of arctic research in order to assist him in the encouragement and administration of research efforts within the preserve.

Purposes

- Maintain the environmental integrity of the Noatak River and adjacent uplands to assure the continuation of geological and biological processes, unimpaired by adverse human activity;
- Protect habitat for, and populations of, fish and wildlife, including but not limited to caribou, grizzly bears, Dall sheep, moose, wolves, and for waterfowl, raptors, and other species of birds;
- Protect archeological resources;
- Provide opportunities for scientific research.

Ecological Overview

Noatak National Preserve lies in northwestern Alaska, in the Western Brooks Range, and encompasses over 402 km of the Noatak River watershed. The preserve is north of the Arctic Circle and is approximately 560 km northwest of Fairbanks and 25 km northeast of Kotzebue at its closest point.

The Noatak basin is bounded on the north and the northwest by the DeLong Mountains and is considered part of the Arctic Mountains Physiographic Province. The DeLong mountain range contains rugged, narrow, glaciated ridges between 1,200 and 1,500 m in elevation with a local relief of 457 to 915 m. Rivers on the north and west of the mountains drain into the Beaufort and Chukchi seas. The lower, western end of the mountain range trends southward to become the Mulgrave Hills, which divide the central Noatak basin from the Chukchi Sea coast on the west. From the Mulgrave Hills the Noatak River flows south into Kotzebue Sound.

To the south of the Noatak drainage are the Baird Mountains, ranging from 760 to 915 m in elevation. The Baird Mountains slope gently northward toward the Noatak basin and divide it from the Kobuk drainage to the south.

The lowland area formed by the Noatak River drainage can be divided into two distinct zones. The Mission Lowlands, on the downstream end of the Noatak River, encompass a broad, flat, tundra area, which has numerous permafrost features including thaw lakes, pingos, and a forested floodplain. Permafrost is discontinuous along the actual drainage. The Aniuk Lowlands are an irregular rolling plain to the north of the drainage that slope gently toward the Baird Mountains on the south and are underlain by continuous permafrost.

The Noatak River is 435 miles long and flows westward from within the central western Brooks Range to Kotzebue Sound and the Chukchi Sea on Alaska's northwest coast. The river crosses more than a third of arctic Alaska, draining an interior plateau valley of 32,633 km2 in the Arctic Mountains Physiographic Province.

From a point just west of Lake Matcharak, at Douglas Creek, the Noatak River enters the preserve. A major moraine belt begins along the valley below Douglas Creek. There the river channel becomes filled with boulders. Below the Aniuk River confluence, the Noatak valley floor widens into a broad plateau, flanked by bedrock ridges 32 to 64 km apart. The valley floor is, in fact, a vast till plain into which the river and its modern floodplain are incised to a depth of 60 m or more. Nearly continuous lines of 30-km-high bluffs border the floodplain or intersect the river's course in places where the river flows against them.

In the middle of Noatak National Preserve, the landscape is characterized by immense sweeps of tundra country, which is dotted with ponds and marshes. This landscape extends beyond the lower morainal ridges to the distant mountain edges of the basin. The Noatak's broad central basin extends some 80 km west to the Aglungak Hills near the Nimiuktuk River confluence. There the valley narrows again, sometimes to less than three miles wide. The surrounding mountains reach heights of 609 to 915 m. This 105-km-long valley is known as the "Grand Canyon of the Noatak". At the lower end of the valley the river cuts for 11 km through the spectacular Noatak Canyon, a gorge with vertical walls of metamorphic rock some 60 to 90 km high. The Noatak River bends to the south just downstream of the Kelly River, leaves the preserve, and enters a lowland forested plain. The river enters a broad, coastal delta zone before emptying into Kotzebue Sound just north of Kotzebue.

The Noatak River Basin was recognized in 1976 for its international importance as a "biosphere reserve" under the Man and the Biosphere program by the United Nations Educational, Scientific, and Cultural Organization (UNESCO).

Climate

The climate of the northwest region is characterized by long, cold winters and cool, sometimes wet summers. While the coastal area experiences a predominantly maritime climate, the interior area, which includes the Noatak and Kobuk river drainages, experiences a more continental climate, with greater seasonal variations in temperatures and precipitation. Summer temperatures for the northwest region range from ~ 0°C to 15°C). Winter temperatures for the region range between –17 and –28°C.

The coastal areas typically receive regular high winds. Mean monthly winds at Kotzebue are above 10 knots from September through April and blow from the east. Mean wind speeds are comparable during the summer months (average 10.5 knots) but are from the west. August and September are the windiest months, while the most extreme winds are associated with winter storms. Wind speeds are somewhat less in the interior than at the coast.

Coastal and lower elevation areas in the southwest portion of the region receive approximately 25 cm of precipitation annually. Higher inland areas to the east receive 63 to 76 cm of moisture. Rainfall usually increases as the summer months progress, usually peaking in August. Annual snowfall ranges from 114 cm in the southwest to more than 250 cm at higher elevations in the east.

Freeze-up of surface waters generally occurs from early to mid October and breakup occurs in mid to late May. At Kotzebue freeze-up usually occurs about October 23 and breakup about May 31.

Geology

The basic geological framework of the northwest region was set by the late Paleozoic era and included the Brooks Range geosyncline (a broad sedimentary trough), the Arctic Foothills, and the Arctic Coastal Plain. During the Triassic period (Mesozoic era), the site of the present Brooks Range was stabilized, and limestone and chert were formed. The process of mountain-building began during the mid-Jurassic period. By the Cretaceous period the Brooks Range dominated the landscape, and volcanic activity from the Jurassic period continued in an area south of the range.

The sedimentary rocks of the Brooks Range and the DeLong Mountains were intensely folded and faulted during the late Cretaceous period. It was during this time that the existing east-west fault trends within the area were established. A resurgent strong uplift during the early Tertiary period (Cenozoic era) was responsible for the present configuration of the Brooks Range. Volcanic activity produced intrusions and debris throughout the region during the Tertiary and Quaternary periods.

Bedrock geology of the DeLong Mountains includes faulted and folded sheets of sedimentary clastic rocks with intrusions of igneous rock. Shale, chert, and limestone of Paleozoic and Mesozoic eras are dominant. Graywacke and mafic rock of the Jurassic and Cretaceous periods are also found.

The lowland area of the Noatak drainage is underlain primarily by siltstone, sandstone, and limestone of the mid-to-late Paleozoic era. Also in evidence are graywacke, chert, and igneous rock of Mesozoic origin.

The Baird Mountains south of the lowland are composed of strongly folded sedimentary rocks with granitic intrusions. Known bedrock consists primarily of Paleozoic or older, highly metamorphosed rocks.

Permafrost plays an important role in the geologic processes and topographic development of the preserve. The Noatak drainage and adjacent lowland areas are underlain by discontinuous permafrost, and areas in the Baird and DeLong mountains are underlain by continuous permafrost. Permafrost can reach depths of 610 m, but is generally between 4 and 79 m in the Noatak area.

Continental ice sheets did not cover all of northwest Alaska during the Pleistocene period, although glaciers did cover most upland areas. The last retreat of the glaciers, about 4,500 years ago, established the present sea level and the extensively glacially carved landscape that is in evidence today. This landscape is characterized by deep, U-shaped valleys, rocky peaks, and braided streams. A portion of the Noatak valley lowland was glaciated during Wisconsin time and today is typified by such glacial features as kame, kettles, moraines, and alluvial till.

Soils

The three major soil types within the preserve include the upland or mountain slope soils of the lithosol type, tundra soils, and soils associated with the Noatak drainage and lowlands. Lithosol soils on the higher slopes of the DeLong and Baird mountains are limited and are mostly imperfectly weathered rock fragments and barren rock. The soil is without zonation and consists of a thin layer of highly gravelly and stony loam. Where this soil accumulates in protected pockets on mountain slopes, it supports mosses, lichens, and some dwarf shrubs. Below the upland soils on more gently rolling terrain, the tundra soils predominate. These are dark, humus-rich, nonacid soils. Texture in the tundra soils varies from highly gravelly to sandy. The floodplains of the Noatak and its tributaries are characterized by silty and sandy sediments and gravel. These soils occur in association with the greatest proportions of organic material along the lower reaches of the Noatak. A fibrous peat extends to the permafrost layer in many areas.

Soil erosion along the Noatak riverbanks is considered severe. This occurs during spring breakup when high volumes and velocities of water scour the riverbanks and carry sediment downstream. In places where waters contact ground ice in adjacent riverbanks, thermal erosion can occur. As the ice melts, banks are undercut and sediments are swept downstream. Additional erosion can occur during high precipitation and storm periods in summer.

Vegetation

At higher elevations (generally 760 to 1,500 m) on windswept, well- drained, rocky slopes of the Baird and DeLong mountains, an al pine tundra community is found. Vegetation is sparse and consists of willow, heather, and avens in combination with grasses, sedges, wildflowers, and mosses. Lichens and saxifrages are common in drier areas. The al pine tundra forms a low vegetative mat no more than a few inches high.

Below the areas of alpine tundra along the foothills of the Noatak River valley, a moist tundra community predominates. This community is the most extensive type within the Noatak National Preserve and in many areas consists almost entirely of pure stands of cottongrass. Shrubs and other species found in moist tundra include willow, dwarf birch, Labrador tea, Lapland rosebay, mountain alder, mountain avens, and saxifrages. Bog rosemary, cranberry, and butterwort are found in wetter areas.
In tundra areas where water stands for most of the summer and peaty soil inhibits water percolation, such species as bluejoint, pendant grass, sedges, and rushes are in evidence and mosses become more

abundant. Herbaceous plants including salmonberry, louseworts, and marsh fivefinger occupy less boggy locations.

On the beach ridges of some larger lakes, such as Feniak Lake, elements of the alpine and moist tundra intermingle with the shrub community. In these few areas a great profusion of vascular plants (more than 200) thrive and produce a spectacular display of vegetation.

A spruce forest community is found on south-facing foothills, valley bottoms, well-drained river terraces, and some lowlands that are generally downstream from the Kugururok River. The upland spruce forest occupies a major portion of the lands flanking the lower reaches of the Kelly, Kugururok, and Eli rivers and appears on the foothills of the Baird Mountains. Nearly pure stands of white spruce are found in association with paper birch, aspen, balsam poplar, and black spruce. Understory shrubs are sparse and include willows and northern red currant. Ground cover consists of sphagnum mosses, reindeer lichens, dwarf shrubs, ferns, and grasses.

On well-drained river terraces east and south of Noatak Canyon, a lowland spruce-hardwood forest is found. White spruce is dominant in association with some black spruce and paper birch. The understory is willow, dwarf birch blueberry, bog cranberry, crowberry, fireweed, and a variety of grasses, sedges, and mosses. The forest is generally open, with mainly mature trees of 15-18 m high.

Small stands of balsam poplar occur on well-drained, south-facing slopes in isolated areas that are generally downstream from Makpik Creek. In these cottonwood patches, seldom more than a few acres in size, such species as bearberry, soapberry, and shrubby cinquefoil form the understory.

Shrub communities are often found on gravel bars and along riverbanks of the Noatak and its tributaries. This vegetative type is dominant along the floodplain of the Noatak and its tributaries west of the Noatak Canyon. Shrubs are generally between 1 and 3 m high with no tree development. Willows are dominant, often in association with dwarf birch and alder. Herbaceous species including river beauty, willow herb, fireweed, and an abundance of grasses and sedges are also found.

Aquatic vegetation is found along the shores of shallow ponds and lakes and in the marshes of the Mission Lowlands. Dominant species are pendant grass, marsh horsetail, marestail, northern burreed, buckbean, sedges, and grasses. Submerged vegetation includes pondweed, watermilfoil, and duckweed. Vegetation in the shallow freshwater ponds provides important habitat for insects and animals.

Freshwater Resources

The Noatak and Kobuk rivers are the principal surface water resources within northwest Alaska. The Noatak is the eleventh largest river in Alaska in terms of the area it drains. Before flowing into Hotham Inlet of Kotzebue Sound, the river drains 32,600 square kilometers and has an average annual flow of 309 m3 per second. The main artery of the Noatak is 700 km long. Eleven relatively large streams, from 50 to 160 km long, are tributary to the Noatak, as are 37 smaller unnamed streams.

Many lakes are within the Noatak watershed. Feniak Lake is the largest within the preserve boundary. Countless thaw ponds and potholes occur throughout the area, most as a result of permafrost that impedes the downward percolation of water that collects in depressions. Other ponds and lakes were formed as detached oxbows of the meandering river or developed as part of the extensive flat delta at the mouth of the Noatak River. Lake waters are generally lower in dissolved solids than river waters. Tundra lakes, however, are often characterized by unpleasant odor and brownish color or by the presence of iron. Lowland surface waters are generally high in organic material.

Approximately 22 species of fish are found within the Noatak drainage. Arctic grayling and arctic char are the most common sport fish. Both spawn on sandy gravel substrate shortly after breakup in the Noatak and its tributaries. Most char are anadromous and are found in the Noatak River and its tributaries upriver as far as the Kugrak River. Chum salmon are found throughout the Noatak drainage; sockeye, coho, king, and pink salmon are also present, but in fewer numbers and confined to the lower reaches of the Noatak River.

Inconnu, or sheefish, inhabit the lower Noatak River. Lake trout are found in some larger and deeper lakes (Feniak, Desperation, Kikitutiorak and Narvakrak). Burbot, or freshwater cod, also inhabit deep lakes and large streams. Northern pike, whitefish, and least ciscos inhabit rivers and lakes in the region. The long-nosed sucker is found in rivers, streams, and lakes in the Noatak drainage and is occasionally dried or smoked for eating. The slimy sculpin and the nine-spined stickleback are common prey fish. Blackfish inhabit lowland ponds in the lower Noatak.

Map 1. Overall Physiography. *Elevation data, major rivers, and lakes of the Arctic Network parks and surrounding area. Digital elevation model 90m grid for Alaska, from best available Digital Elevation Models (DEMs). In areas of missing data, 300m and/or 60m DEMS were used. Selected major rivers were extracted from all rivers and streams in the USGS 1:2,000,000 Digital Line Graphs (DLG) dataset. The major rivers include the Copper, Susitna, Kuskokwim, Yukon, Koyukuk, Kobuk, Noatak, and Colville Rivers. Statewide lakes were assembled from seventeen separate files in the USGS 1:2,000,000 Digital Line Graphs (DLG) dataset and include only those polygons with AREA greater than 20 acres (80,940 m2). Statewide roads from the USGS 1:2,000,000 DLGs database and described as: Primary, Secondary (all weather, hard surface), Light Duty (all weather, improved), Unimproved (fair or dry weather). Source: AK Department of Natural Resources (AK-DNR), Land Records Information Section 1982.*

Map 2. General Land Status. *Land ownership records for the State of Alaska. Data extracted from Bureau of Land Management's (BLM) records, stored in Alaska Land Information System (ALIS) on January 2, 2001; and AK-DNR land records stored in the Land Administration System (LAS) on January 10, 2001.*

Map 3. Mineral Extraction. Map of mining claims, coal resources, oil and gas basins, placer deposits and major roads in the Arctic Network and surrounding area. State mining claims, prospecting sites, federal claims either selected or patented, within the State of Alaska based on current BLM case-type, case-status and land status information used to classify data from federal land records stored in the ALIS). Location of coal resources within the State of Alaska is based on the 1986 Map of Alaska's Coal Resources, Alaska Division of Mining and Geological & Geophysical Surveys, Special Report 37, in cooperation with the Alaska Coal Association. Oil and Gas Basins are digitized from the DGGS publication, Oil and Gas Basins Map of Alaska 1983 (Special Report 32), Alaska Dept. of Natural Resources, Division of Geological & Geophysical Surveys. Placer district boundaries are shown as groups of geologically and geographically related placer deposits. Economic and significant heavy metals are also reported for each district. Placer data was digitized from 1:5,000,000 map contained in U.S. Geological Survey Bulletin 1786, Plate #2. Location of Significant Metalliferous Placer Districts of Alaska, July 1991. Statewide roads from the USGS 1:2,000,000 DLGs database and described as: Primary, Secondary (all weather, hard surface), Light Duty (all weather, improved), Unimproved (fair or dry weather) (AK Department of Natural Resources, Land Records Information Section 1982).

Map 4. Alaskan Ecosystems. *1973 map of "Major Ecosystems of Alaska" shows the distribution of nine classes of ecosystems within a single hierarchic level. Scale of coverage is 1:250,000. The focus of the ecosystems map is on the regional distribution of vegetation community type and structure. Information relating to other landscape characteristics, such as topography, hydrology, and climate, is considered only so far as it influences ecosystem type. The resultant classes contain much variability in environmental characteristics that are not reflected in the ecosystem type. For example, the "Alpine Tundra" ecosystem class encompasses mountain formations of different geologic origin and climatic regime (National Park Service, Alaska Support Office).*

Map 5. Precipitation Map. *Areas of equal annual precipitation for the Arctic Network and surrounding areas. Created from a 1:2,000,000 scale map showing lines of equal annual precipitation in Alaska in 1994 as part of a flood frequency study of the streams and rivers of Alaska. The original purpose of the precipitation map of Alaska was to provide precipitation values for use in computing flood peaks and their associated recurrence intervals at ungaged rivers and streams in Alaska. The precipitation map was developed using a relatively small number of precipitation stations and the map has large intervals between contours of equal annual precipitation. Thus caution should be used when interpreting precipitation values (Jones, S.H., and Fahl, C.B. 1994. Magnitude and frequency of floods in Alaska. U.S. Geological Survey Water-Resources Investigations Report 93-4179).*

Map 6. Weather Stations. *Operating automatic and manual weather stations in, or near the Arctic Network. Created from a database of Remote Automated Weather Stations (RAWS) and manual weather stations maintained by the Bureau of Land Management, Alaska Fire Service. RAWS are solar/battery powered weather stations maintained through a co-operative agreement between U.S. Bureau of Land Management, State of Alaska, U.S. Fish and Wildlife Service, National Park Service, and U.S. Forest Service. RAWS collect a variety of weather data (temperature, precipitation, wind speed, etc.) and transmit three hours worth of data every three hours. As a result, hourly records of weather data are accumulated. Alaska Fire Service maintains 52 weeks of data online.*

Map 7. Wild and Scenic Rivers. *Represents existing wild and scenic rivers and river segments in the Arctic Network. The source of this data is USGS 1:2000000 DLG (Digital Line Graph) hydrography data files. Wild and scenic rivers and river segments were identified from the existing USGS files.*

Map 8. USGS Aquatic Data Resources. *Geological Survey Water Resources NWIS database (http://waterdata.usgs.gov/ak/nwis/rt) was searched for historical and ongoing datasets. All sites within ARCN's boundaries or immediately downstream of a stream originating in ARCN parks are included in this map. One hundred and forty historical USGS data collection sites exist of potential interest. The majority of these sites were single water quality samples collected anywhere from the early 1950s to most recently, 2002. Eleven groundwater sampling sites were established near Anaktuvik Pass and along the Noatak River. No discharge stations exist within the parks but six stations are downstream of tributaries originating in the parks.*

Map 9. BELA Major Waterbodies. *Map of streams and lakes in BELA and surrounding areas. Statewide rivers and streams were assembled from eighteen files in the USGS 1:2,000,000 DLG dataset. Statewide lakes were assembled from seventeen separate files in the USGS 1:2,000,000 DLG dataset and include only those polygons with AREA greater than 20 acres (80,940 m^2).*

Map 10. BELA Human Activities. *Map of mining claims, coal resources, oil and gas basins, placer deposits, RS2477 trails, and major roads in BELA and surrounding area. See Map 3 for complete description of data sources.*

Map 11. CAKR Major Waterbodies. *Map of streams and lakes in CAKR and surrounding areas. Statewide rivers and streams were assembled from eighteen files in the USGS 1:2,000,000 DLG dataset. Statewide lakes were assembled from seventeen separate files in the USGS 1:2,000,000 DLG dataset and include only those polygons with AREA greater than 20 acres (80,940 m2).*

Map 12. CAKR Human Activities. *Map of mining claims, coal resources, oil and gas basins, placer deposits, RS2477 trails, and major roads in CAKR and surrounding area. See Map 3 for complete description of data sources.*

Map 15. GAAR Major Waterbodies. *Map of streams and lakes in GAAR and surrounding areas. Statewide rivers and streams were assembled from eighteen files in the USGS 1:2,000,000 Digital Line Graphs (DLG) dataset. Statewide lakes were assembled from seventeen separate files in the USGS 1:2,000,000 DLG dataset and include only those polygons with AREA greater than 20 acres (80,940 m2).*

Map 16. GAAR Human Activities. *Map of mining claims, coal resources, oil and gas basins, placer deposits, RS2477 trails, and major roads in GAAR and surrounding area. See Map 3 for complete description of data sources.*

Map 17. GAAR Alpine Glaciers (East). *Glacier locations and extents were estimated from a mask of the "ice/snow" class in the GAAR landcover map. Low-lying areas of Aufeiss were manually removed.*

Map 18. GAAR Alpine Glaciers (West). *Glacier locations and extents were estimated from a mask of the "ice/snow" class in the GAAR landcover map. Low-lying areas of Aufeiss were manually removed.*

Map 13. NOAT/KOVA Major Waterbodies. *Map of streams and lakes in NOAT and KOVA and surrounding areas. Statewide rivers and streams were assembled from eighteen files in the USGS 1:2,000,000 DLG dataset. Statewide lakes were assembled from seventeen separate files in the USGS 1:2,000,000 DLG dataset and include only those polygons with AREA greater than 20 acres (80,940 m2).*

Map 14. NOAT/KOVA Human Activities. *Map of mining claims, coal resources, oil and gas basins, placer deposits, RS2477 trails, and major roads in NOAT and KOVA and surrounding area. See Map 3 for complete description of data sources.*